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B.S.F.A.

The British Steel Founders' Association has for its objects the furtherance of the interests of the users and makers of steel castings as well as the workers in the industry. The steel castings industry is, by comparison with iron and brass founding, not an old one—the first steel castings were made in the 1850's. Nor is it a particularly large one, since there are no more than 70 steel founders in the country. These range from small foundries, producing under 10 tons of castings each week, to those whose output has been as high as 400 tons each week. The importance of steel castings to the engineering industry is very great, and, with increasing technological progress in the engineering industry, the need for steel castings will rise further. The range of weight and diversity of application of steel castings is extremely wide. Steel castings, of which there are sometimes several to the ounce, are used in all radio sets, while, at the other end of the scale, are castings weighing up to 200 tons each for forging presses.

It is not generally known that, volume for volume, a steel casting—properly made and heat-treated—is the strongest type of construction possible. It is stronger per cub. in. than any other cast metal, and has superior physical properties to any forging, since—unlike a forging—its strength is not uni-directional. Steel castings can be produced to meet almost any set of service conditions, including those involving the highest temperatures or corrosive conditions. The war which has just ended saw a spectacular rise in the need for steel castings, and great strides were made by steel founders, not only in providing the much increased tonnage, but in meeting the many demands for altered or increased physical properties to suit the requirements of the Services. Additionally, much improved equipment for steel melting, moulding, coremaking, sand preparation, sand handling, and heat-treatment was installed throughout the industry. In no instance did the industry fail the country, and remarkable advances were made in the technique for producing steel castings—particularly in alloy steel of all types.

Much of this progress was due to the spirit of good fellowship which has always existed among steel founders, and the ready way in which they worked together, under the ægis of the B.S.F.A., to solve the difficult technical problems. On every occasion the technical and scientific resources of the bigger steel founders were available to assist the industry at large, though, in many instances, the smaller founder was responsible for the initiative which solved the particular problem on hand. The success of these co-operative efforts has led to the permanent widening of the constitution of the B.S.F.A. to embrace all phases of the industry, and standing technical, development, and other committees are enthusiastically engaged in pooling wide individual knowledge for the common good, and formulating standards of practice on such matters as inspection, testing (including radiography and other non-destructive methods), costing and cost presentation, steel melting practice, synthetic sands, hydraulic cleaning methods, dust prevention, and apprentice training. Research and investigation into many possible lines for future progress is proceeding on a co-operative basis. Additionally, the Development Committee is undertaking consumer research work to see how best the needs—rather than the known wants—can be met.

It is hoped shortly to cast the links which will ensure regular interchange of information between the B.S.F.A. and other steel founders throughout the world, and a trade mission is now touring Belgium and France studying the present state of the industry there. There is no doubt that work of this character, fostering collective work on all problems which, if solved, would lead to the general advancement of the industry, is in the best interests of the community

Contents

B.S.F.A., 333.—Notes from the Branches, 334.—Forthcoming Events, 334.—Aluminium and Light Alloy Founding, 335.—Welding of Nickel-alloy Steels, 340.—Heat-resisting Alloys for Motor-car Gas Producers, 341.—Essential Work Order, 345.—Correspondence, 346.—A.F.A. Jubilee Congress, 347.—Industry and Research, 348.—Wasters due to Design, 348.—Control of Domestic Heating Apparatus, 349.—Furnace Bottoms, 350.—For Sale, 350.—30 More Government Factories Allocated, 351.—British Iron and Steel Federation, 351.—Personal, 352.

NOTES FROM THE BRANCHES

SCOTTISH.—The annual business meeting was held in the Royal Technical College, Glasgow, on March 9, when Mr. Marshall presided over a large attendance. The reports for Session 1945-46 showed that the branch had made further progress and that the membership was now up to 390, the highest number ever reached in Scotland. Attendances had been good throughout the session. All the various sides of the foundry industry had been catered for.

Interest was given to the proceedings by the report on the "John Surtees" Competitions which, this year, had again been held in Scotland. In both the senior and junior sections there had been a considerable number of entries, and the examiner's report revealed that the standard reached by all who had entered was extremely satisfactory. In the senior section the Gold Medal and first prize were won by Mr. Thomas H. Sneddon, Motherwell, and the second prize by Mr. John Steele, Wishaw. In the junior section the Silver Medal and first prize were won by Mr. James S. Stewart, Hamilton, and equal second prizes by Mr. George Dickson, Motherwell, and Mr. James Horsburgh, Bathgate. It is noteworthy that all the winners, with the exception of Mr. James Horsburgh, were Clyde Alloy Steel Company apprentices. Those in the senior section had now completed their apprenticeship, and while Mr. Sneddon had remained in the Clyde Alloy Company's Works at Craigneuk, Mr. Steele was now employed by G. & J. Weir, Limited, Glasgow. It was also pointed out that all the prize-winners were students in the foundry and pattern-making classes at the Stow College, Glasgow, and that even during the black-out winters they had travelled long distances after finishing their day's work to attend evening classes there.

In the unfortunate absence of Mr. Gardom, President of the Institute, Mr. Daniel Sharpe, past-President, presented the prizes. The examiner in both sections was Mr. A. Campion. For the ensuing session Capt. T. Shanks, Denny, was elected President, and Mr. R. O. Paterson and Mr. William Y. Buchanan vice-Presidents. Representatives elected to represent the branch in the General Council were Mr. William Y. Buchanan, Mr. John Cameron, Jr., Mr. R. R. Taylor and Mr. D. H. Young, and to the Technical Committee, Mr. Evan J. R. Mitchell, Mr. D. A. Charles, Mr. James McPheat and Mr. John Vickers were elected members of the branch Council, and Mr. John Bell was again elected hon. branch Secretary.

Following the business part of the meeting a Paper on "Cupola Operation" was read by Mr. D. H. Young. This Paper, which will be printed later in the JOURNAL, proved to be most interesting and gave rise to a good discussion.

In the evening the branch held its first post-war dinner, when a party of about 90 (a record for the branch) attended. The toast of "The City and Corporation of Glasgow" was proposed by Mr. Thomas White, Paisley, and replied to by the Rt. Hon. the Lord Provost of Glasgow. Mr. P. A. Abernethy, vice-Chairman of Council, B.C.I.R.A., proposed "The

(*Continued at foot of next column.*)

FORTHCOMING EVENTS

(Secretaries are invited to send in notices of meetings, etc., for inclusion in this column.)

MARCH 29.

Keighley Association of Engineers :—"The Universe Around Us," by D. W. Dewhirst. At Devonshire Buildings, Devonshire Street, Keighley, at 7.30 p.m.

APRIL 2.

Institute of Vitreous Enamellers :—"Up-Grading the Vitreous Enamelling Industry," by J. H. Gray. At Charing Cross Hotel, at 6.30 p.m.

APRIL 5.

Institution of Mechanical Engineers :—"The Evolution of a Tank Transmission," by H. E. Merritt. At Storey's Gate, St. James's, Park, London, S.W.1.

Royal Statistical Society (Industrial Applications Section—London group) :—"Statistics in Radio Valve Component Manufacture," by A. Gait. At the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, at 6.30 p.m.

APRIL 10.

Institute of Welding (West Scotland branch) :—"Fabrication and Welding of Bridging Equipment," by R. G. Braithwaite. At 39, Elmbank Crescent, Glasgow, C.2, at 6.30 p.m.

APRIL 11.

Institute of Welding (N.E. Tyneside branch) :—"Mild Steel Weld Metal from the Point of View of 'Snow Flakes,' Porosity, etc.," by H. F. Tremlett. At the Mining Institute, Neville Hall, Newcastle-upon-Tyne, at 6.15 p.m.

Staffordshire Iron and Steel Institute :—"Hardness and Hardenability of Steels," by H. A. MacColl. At the Dudley and Staffordshire Technical College, The Broadway, Dudley, at 7 p.m.

APRIL 12.

Institution of Chemical Engineers :—Annual corporate meeting. At the Connaught Rooms, Great Queen Street, London, W.C.2, at 11 a.m.

Institute of Welding (E. Scotland branch) :—Annual general meeting; "Technical Efficiency in the Welding Shop from Design to Inspection of Finished Product," by F. Koenigsberger. At the Heriot Watt College, Chambers Street, Edinburgh, at 7.30 p.m.

Keighley Association of Engineers :—"The Development of British Jet Propulsion," by G. B. R. Feilden. At Devonshire Buildings, Devonshire Street, Keighley, at 7.30 p.m.

APRIL 24.

Institute of Welding :—"The Evolution of Welded Armoured Fighting Vehicles," by Major R. J. Fowler and Major L. F. Denaro. At the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, at 6 p.m.

Institute of British Foundrymen

MARCH 30.

East Midlands branch :—Annual meeting and short Paper competition. At the Technical College, Derby, at 6 p.m.

Wales and Monmouth branch :—"Production of Tank Wheels in a Mechanised Blackheart Malleable Foundry," by A. B. Bill and J. Peers. At Newport.

NOTES FROM THE BRANCHES

(*Continued from previous column.*)

Institute," to which the President, Mr. Gardom, responded. Other toasts were "H.M. Forces," proposed by Mr. D. H. Young and replied to by Capt. T. Shanks, and "The Scottish Branch," proposed by Mr. James Ferguson, M.A., B.Sc., H.M. Inspector of Schools, and replied to by Mr. Alex. Marshall, branch President.

BRISTOL & WEST OF ENGLAND.—The annual general meeting has been postponed from April 6 to a later date yet to be arranged.

ALUMINIUM AND LIGHT ALLOY FOUNDING*

By Dr. E. W. FELL

[ABRIDGED]

It can be said that the founding of the light alloys is an art, indicative of the skill of the craftsman in just the same way as the casting of iron and bronze has held its high position as an art during past centuries. However, compared with iron and bronze, the casting of aluminium may be traced back only some 40 years or so. The commercial use of aluminium may be regarded as starting from the production of virgin aluminium ingot by the electrolytic process of extraction of the metal from its oxide, towards the end of the last century. Even in modern times, as a result of the war, a great increase has taken place in the tonnage of castings produced in aluminium alloys. Similarly, magnesium and its alloys, which were very largely pioneered in the early days by Germany owing to the extensive deposits of magnesium-bearing ores in that country, now hold an important place. Like aluminium, commercial magnesium-metal for ingot is produced by processes of extraction in electrolytic cell-rooms. Although magnesium alloys are of still more recent application than aluminium alloys, the recent war has resulted in all the main belligerent countries greatly extending their magnesium production.

Comparison with Iron

By way of comparison, there are certain prominent differences between the founding of the light alloys and of iron. For example, iron may be heated to a high temperature in the cupola, but aluminium and magnesium alloys in the molten condition must be maintained within definite and low limits of temperature. The cooling contraction of aluminium in inches per foot is larger than for ordinary cast iron. More massive risers and risers of special shape are also used to allow for the greater liquid contraction. This extended use of risers for feeding purposes is similarly necessary with the magnesium alloys. Again, the practice up to now has not been to have furnaces of large capacity for the production of light alloys in the castings foundry, for the furnaces used are mostly oil-fired, gas-fired or electric furnaces.

Light alloys may be divided into two main groups of casting alloys: (*a*) aluminium and its alloys, and (*b*) magnesium and its alloys. It is true to say that the reason for their use in engineering is their high strength-weight ratio compared with other metals. For example, aluminium is only about one-third of the specific gravity of iron and steel, and magnesium about one-quarter. At the same time, the strength of aluminium alloy castings, on tensile test, show high yield stresses and breaking stresses of up to 20 tons per sq. in. and more, and magnesium alloy castings show an ultimate breaking stress up to about 16 tons per sq. in.

*A Paper read before the Lancashire branch of the Institute of British Foundrymen.

Aluminium Melting Practice

With regard to aluminium melting practice, the furnaces employed in aluminium foundries are usually oil-fired and of the Morgan tilting-type having a capacity of about 500 lbs. Furnaces of similar capacity are also heated by electrical resistance methods. The total time taken to melt down the charge in a Morgan furnace is 1½ to 2 hours. Creosote pitch is now used as a fuel. Salamander crucibles, which contain graphite embodied in the clay, are used in a variety of sizes for melting purposes. Crucibles should be kept in a dry store, and well heated in the melting furnace before charging with metal.

Alloying may be carried out in these furnaces, or the required alloy in ingot form is alone melted down. The molten charge is not allowed to become heated too much above the fusion point, and especially in the case of certain alloys, notably those aluminium alloys containing considerable percentages of magnesium.

Before casting, the molten metal may be de-gassed by means of chlorine, nitrogen, or by proprietary products on the market for this purpose.

Grain Refining.—There are occasions when it is required to avoid large grain size in castings from certain alloys. Titanium or columbium may be added to the metal in the form of an intermediate alloy. The metal is then well stirred and skimmed. Only a very small quantity of grain-refiner is needed. Boron, in the form of salt cakes, is also an excellent grain-refiner and very convenient for treating small quantities of metal. The cakes are plunged and held well in the molten metal until all reaction has ceased. The surface of the bath is then skimmed before casting.

The melting, refining and care of the molten metal up to the moment of casting is more important with some of the alloys than with others. Nevertheless, constant technical supervision everywhere is very necessary to ensure that the molten metal is at the correct temperature, that pots and ladles are clean and free of dross, and also to make certain that the foundry practices laid down are always strictly adhered to, that test-bar moulds are properly poured and that no adulteration of the metal shall occur in foundries where many different alloys are dealt with simultaneously.

Maintaining Furnaces.—Furnaces known as "maintainers" are employed for the purpose of providing a steady supply of molten metal for the casters, especially for the die-casters. The "maintaining" furnaces are replenished at time to time by ladles of metal direct from the Morgan melting furnaces. The "maintaining" furnaces may be fired with creosote pitch.

Aluminium Casting Procedure

The accurate control of casting temperature is important, and for a particular alloy the temperature of

Aluminium and Light Alloy Founding

casting will vary according to the nature of the mould —an intricate casting with thin walls obviously requiring hotter metal. In a general way, casting temperatures vary from about 680 to 730 deg. C. Apart from a clean surface skin to the alloy when in the ladles, all surface dross should be removed by skimming before casting.

The flow of the liquid metal into the mould should be steady and rapid. Agitation and turbulence of the metal must be avoided as much as possible to avoid air, oxide and non-metallics being entrapped in the castings. Hence, bottom gating is the practice. Further precautions such as split sprues and scum traps are employed for the same reason. This applies especially in magnesium alloy casting. Pouring basins are also used in magnesium casting to reduce turbulence of metal entering the sprue and the basins should never be permitted to empty during casting, thereby ensuring a regular pouring speed. Owing to the lower density of aluminium and magnesium compared with other metals and to their higher solidification shrinkage, it is necessary that large and high risers be incorporated on most castings. The solidification of the castings should progress evenly from the base of the casting upwards.

To assist feeding the sprue height may be further increased by placing a pouring cup on the top of the moulding box. A 6-in. column of aluminium gives a pressure of ½ lb. per sq. in. Gates and risers should be rounded and filleted to prevent shrinkage cracks at the point of contact with the casting. A generous use of chills is accepted practice in light metal foundries; these are generally of cast iron, but copper is also used. Moulding technique presents few unusual features. Moulding by hand is customary in foundries producing many different castings, but obviously mechanised methods are general where quantity production is called for.

The position and shape of the risers on a casting requires careful consideration to ensure that "feed" is given to the casting just where it is most needed. The foundryman should also know by visual examination of the surface of a die-casting in aluminium alloys whether the casting has been "starved" of feed metal or not. Experience is acquired by practice in deciding where the risers should be placed, which includes also the examination of fractured or cut off sections through the castings to determine if feed has been sufficient or whether more is necessary.

Amongst interesting castings is one for the A. V. Roe Lancaster heavy bomber. The component referred to is a large support beam for the retractable undercarriage and the support also for the inner engines. The beam is sandcast in an aluminium alloy containing 10 per cent. magnesium—the NA. 350 alloy. Four of these components carry the weight of the whole aircraft in take-off and landing, an indication of the high stresses that the beams have to withstand. That they are tough and resistant to projectiles is shown by the effect on them of enemy cannon shell. The weight of each beam is 128 lb. The overall length of the beam is 5 ft. and the width is 1 ft. at its middle. For the casting operation about 260 lb. of molten metal is required.

Moulding Sands and their Properties

By way of brief reference to the nature of the moulding sands used for casting the light alloys, there is little that is remarkable, or of special interest, about moulding sands for aluminium alloys in general. Green sand is used and when it begins to lose its properties by continual use then some new sand is added to restore it. But, when the aluminium contains about 10 per cent. of magnesium, a specially prepared moulding sand is necessary, and a small proportion of bentonite is added. The magnesium casting alloys require a special synthetic sand composition of their own. Such a sand initially containing about 90 per cent. silica and 10 per cent. alumina might contain up to 10 per cent. yellow sulphur, depending on circumstances, together with a small percentage of boric acid and other additions. The sand should be kept clean. Core sands, again, have their own special compositions. The purpose of these sand mixtures is to prevent chemical reactions occurring between the molten metal and the sand, otherwise there would be vigorous interaction owing to the high chemical reactivity of molten magnesium, and the casting would be ruined. The chemicals added to the sand act by becoming gasified with the heat of the molten metal and they form a blanket of inert protective gas covering the surface of the metal. Any tendency for interaction of metal and mould is thus stifled.

Very important also is good permeability of the moulding sand so that the gases evolved during casting may escape away into the atmosphere. The moisture content of the sand must also be kept low and within well defined limits.

Testing and Inspection Procedure for Aluminium and Magnesium Castings

The inspection and testing procedure for aluminium and magnesium castings consists, besides the casting alongside the mould of tensile test bars, of a close visual examination of the surface of the casting. In this way, any surface defects such as mis-runs or unsoundness are detected. With new and large castings, and where it is necessary to work closely to the dimensions given in the drawing, a dimensional check on the casting may be carried out.

Visual examination of the surface of the casting is supplemented by X-ray examination of the interior of the castings, which for aluminium for aircraft are grouped into three classes in decreasing order of importance under service conditions. Thus, aluminium castings grouped as Class 1 for airframe work are castings used in such a position that a single failure might be the direct cause of structural collapse or loss of control, either in flight or when landing or taking off. Less important castings are grouped into Classes 2 and 3. Those in Class 2 receive a stricter X-ray examination than those in Class 3. The X-ray examination of Class 1 castings is the most exacting, and is such that each individual casting is X-rayed.

Those aluminium castings under 1 in. in wall-thickness are "screened" radiographically, and thicker castings are individually "filmed" radiographically. The X-ray film gives a much more sensitive mode of detecting any existing defects, which might be overlooked on "screening" thick sections of metal.

During the last year or so, tests have been made on a novel method for the visual detection of surface cracks in castings. The castings are dipped into a bath containing liquid which has the power of fluorescing strongly when exposed to ultra violet light. What actually happens is that any cracks present in the casting are filled or partly filled by the liquid. The casting is then quickly rinsed in a second bath to remove the liquid from the surface in such a way so as to retain the liquid in the cracks. When the casting is now viewed under a special electric lamp, the liquid left in the crack fluoresces strongly, and the crack is thus shown up brilliantly. The advantage of this process is the ease in which a fine crack is discovered. Nevertheless, ordinary visual inspection of the surface of a casting with the aid of an ordinary magnifying-glass is also a very accurate method of detecting cracks, in the hands of those skilled at the work, though the examination is more tedious.

Defects to be Avoided

This account would, perhaps, not be complete without mentioning the chief defects which are liable to occur in aluminium castings and how such defects may be avoided. Undoubtedly, the main defect encountered in aluminium castings is the presence of small cavities, internal porosity or microporosity, due to shrinkage or contraction of the molten metal during solidification or cooling in the mould. Shrinkage defects are liable to be met when making for the first time castings of new design, since it may be only after some trial before the appropriate risers can be found so that the shrinkage may be eliminated by suitable feeding in the majority of cases, or sometimes eliminated by the judicious use of chills.

The next defect in aluminium castings in order of importance is the presence of surface cracks caused by internal stresses during cooling of the castings. Such cracks may occur at changes of section in the casting and be avoided, for example, by increasing the radii at sharp bends. Other types of cracking may be caused by too high a casting temperature, or by insufficient yielding of the mould so as to accommodate the contraction of the casting while it is cooling down.

The third defect which may be encountered in aluminium castings is porosity or unsoundness due to gas. This is also known as "pin-holing," owing to its appearance as a regular distribution of small round cavities of the size of pin-holes or gas bubbles throughout the casting. The cause of this defect is the presence of hydrogen gas in the molten metal: the source of this hydrogen being water-vapour, moisture or other hydrogen compounds such as fuel oil vapour in the atmosphere of the metal melting furnace, or corrosion products on the surface of the original ingot which has been exposed to corrosive atmospheres before melting down. The moisture or other hydrogen compound is reduced chemically by the metallic aluminium and the hydrogen evolved is absorbed by the molten metal. That is one of the reasons why aluminium should not be kept molten at a high temperature because, as with other metals, its power to dissolve gas increases with increasing temperature. When the trouble occurs, there are several good methods of "de-gassing" which may be made use of.

Founding of Magnesium and Its Alloys

Owing to the special characteristics of magnesium metal and to its somewhat recent development in this country, the foundry processes employed with magnesium alloys appear novel and interesting.

It is convenient in the foundry to melt down ingots of the particular alloy required. All melting for refining castings is carried out in soft steel welded or pressed pots up to 500 lb. capacity, because the amount of iron picked up by molten magnesium is very small. Furnaces are gas-fired, and are also so designed that the outside of the iron pot is very uniformly heated all over its outer surface. Uniform heating of the furnace charge is necessary in order to preserve the life of the pots and, secondly, owing to the highly combustible nature of the metal especially when molten. It is very dangerous to bring the molten metal even into contact with water.

During melting down, the metal is kept covered by a protective flux, consisting of mixtures of the chlorides, fluorides and oxides of magnesium, potassium, calcium and sodium. Fluxes, depending on the proportions of the constituents, may not only act as a protective agent by preventing any local burning or fire in the furnace charge, but may also act as refining fluxes for the molten metal. During casting, the stream of molten magnesium alloy issuing from the ladle is protected from burning by keeping it dusted with powdered sulphur. The molten metal shows less tendency to burn if a small addition of calcium is added to it.

In order to refine the grain of the castings, the molten alloy, before casting it into ingot, is subjected to what is known as the "superheating" process. "Superheating" also increases the strength of the material and improves its castability. This process is very important, and consists in heating the pot and its contents to a high temperature, which is up to about 200 deg. C. above the actual casting temperature—for example, up to 850 to 900 deg. C. for a period up to an hour. However, only a short time at the maximum temperature may suffice, but it is important that the molten metal should be brought slowly up to that temperature, and cooling down afterwards must be conveniently quick. In order to test whether the superheating has been satisfactory, the resulting ingot should be fractured to determine the fineness of the grain. In this way, the casting foundry is ensured of getting good properties from castings, as the beneficial effect of fine grain is not lost when the material is re-melted. The grain refinement produced on "superheating" is attributed by some authorities to the production of very small nuclei distributed throughout the melt.

From time to time, it may be necessary to clean

Aluminium and Light Alloy Founding

up the metal in the pot, which may have become impure by oxidation dross and fluxes. This is known as "refining." For example, a refining flux of the chemical composition referred to just now is placed on the surface of the molten metal allowed to fuse and then worked intimately into the bath. The flux combines with the oxides and impurities, and sinks down with them to the bottom of the pot owing to its greater weight, leaving the metal clear and bright. Refining with salts is carried out at a much lower temperature than "superheating," the range being 700 to 800 deg. C.

Casting Temperature

The casting temperature should be as low as practicable so as to fill and feed the mould. However, casting temperatures for magnesium alloys have to be higher than those for aluminium alloys in order to avoid sluggishness of the molten metal in the mould. The casting operation is not an easy matter, and is made difficult because of the extreme lightness of the magnesium alloys. As a result, air is easily entrapped by the metal, for there is no pressure behind the metal to push it out of the mould. Also, drosses and oxide are readily caught up in the metal and their separation is not easy, hence various devices such as dross traps and specially designed sprues runners and numerous gates are employed. Large and relatively heavy risers are necessary to ensure adequate "feed." For obvious reasons, the mould must be filled as quietly and gently as possible. Really intricate castings have been produced in magnesium alloys.

Perhaps the most serious defect encountered in magnesium alloys is that of micro-shrinkage. Its presence may be shown by serious loss of strength in the casting and by loss of ductility, accompanied by discoloured fractures. It seems there are several factors which contribute to the absence of this trouble. One is adequate "feeding" of the solidifying casting, and another is by using good alloy ingot of suitable chemical composition, and which has been properly "superheated" initially.

Vote of Thanks

After MR. J. JACKSON had proposed, and MR. W. N. COOK had seconded a vote of thanks to Dr. Fell, MR. A. PHILLIPS opened the discussion. He said there were certain matters dealt with in the Paper which stood out very prominently indeed. One was the statement that casting temperatures of aluminium could vary very greatly. It had generally been assumed that the casting of light aluminium alloys was effected within a very close range, and that it was necessary to adopt different pouring methods with larger runners, etc., thus ensuring that casting could be done within a very narrow range of temperature. He would welcome further information upon that point.

Was crack determination more advantageous and quicker when carried out by the fluorescent method than by screen testing? Personally, he was inclined to agree that a radiograph was much better than a screen test, and that there was more revelation by the former.

To digress slightly from the subject matter of the Paper, there was now available an alloy which was like the R.R.50 alloy in its results. In this alloy there was a very narrow range of magnesium. What was Dr. Fell's opinion as to why, in the magnesium range in the alloy, it was found that the limits in the specification were much wider than what could be reconciled with the physical tests in practice. If he remembered rightly the range was approximately from 0.5 to 2.5 per cent., though, in practice, it was usually found that the best results were obtained about halfway between. In the melting of the alloy it was sometimes found that magnesium was lost, which to some foundrymen constituted something of a mystery. Could Dr. Fell state any reason for this occurrence?

DR. FELL observed that it was somewhat difficult to deal adequately with the casting temperatures of aluminium alloys in the course of his lecture, but he quite agreed with Mr. Phillips concerning the size of the pouring stream. The size of the gates could be a determining factor. Screening was not sufficiently sensitive for the detection of cracks on the surface of castings, but filming was definitely better than screening, but even then fine cracks might easily remain undetected and much depended on the actual position of the crack relative to the direction of the X-rays concentrated upon it. The fluorescent method was considered to be better than filming but the use of liquids made the method unpopular. The best method of detecting fine surface cracks was still by means of a trained girl using a hand magnifying-glass.

With regard to the amount of magnesium, and its effect on R.R.50, he had found that the amount of magnesium present had a very marked effect on alloys of rather similar composition and that there was a very much closer limit than was given in the specifications in order to obtain the desired properties. The limits given in the specification, therefore, appeared to be too wide apart. He could not account for the loss of magnesium unless it was due to usual causes when melting aluminium alloys containing magnesium, such as losses by preferential oxidation.

Effect of Humidity

MR. GREENWOOD enquired whether Dr. Fell had had experience of the effect upon castings, owing to humidity in the atmosphere.

Dr. Fell replied that there was a very definite effect with aluminium alloys. Some of the gas evolved during the cooling process, or during the solidification process, could be definitely traced to water vapour, namely, to hydrogen. It was important before melting an ingot to ensure that it had not been exposed to wet so that there could be no likelihood of corrosion taking place with consequent introduction of gas to the melt. Mr. Greenwood had in mind such areas as the Lake District, where there was always humidity in the atmosphere, and where there was a greater tendency for it to be present, than, say, in the South.

Dr. Fell remarked—with regard to magnesium and its

alloys—it seemed obvious that the effect of a relatively high humidity in the atmosphere should not be lost sight of owing to the marked hygroscopical properties of magnesium salts and since raw magnesium was easily corroded.

Mr. Phillips mentioned that there was one point which had been strongly emphasised in the Paper, *viz.*, the weakening of aluminium alloys at a high temperature. Apparently, this only applied to certain aluminium alloys, such as the aluminium-silicon type, which it was understood must not be heated up to 900 deg. otherwise they would be full of gas and become useless; yet it was practicable to heat the metal up to 1,100 deg. and obtain sound castings all of which could be subjected to satisfactory radiological examination. When heating aluminium alloys up to a high temperature attention should be paid to the furnaces and the quality of the fuel, otherwise there would be a hydrogen pick-up. If attention were paid to the type of fuel used and the method of melting, a very high temperature could be employed without deleterious effects.

Cold Chamber Die Castings

Mr. Harlow enquired, with regard to the development on a smaller casting, if the cold chamber high-pressure die casting machine would overcome a certain amount of the micro shrinkage? There appeared to be more or less of a semi-extrusion process where a lower temperature of alloy was used. In all probability that would assist the reduction of micro-shrinkage. In the 300 to 304 range he believed there were developments going on. What would be the effect of using an aluminium die instead of an iron one? He also asked whether there would be any assistance in reducing hot short in castings if such a type of die was used?

Mr. Phillips said that with regard to the cold chamber as contrasted with the liquid machine it had been found that silicon alloys gave a much more solid casting in the cold chamber machine than the copper alloys, whereas in the case of the liquid machine the difficulty was not experienced.

Mr. Needham wished to know whether Dr. Fell considered the small ferrous foundry was incomplete unless he was testing the permeability of sand; whether the moisture content could be a determining factor when detecting defects. Were such tests readily obtainable? His own foundry had not the means of testing permeability.

Dr. Fell thought that permeability, and moisture content, in sands were very important in the case of light alloy castings, but he had no information to offer in regard to their importance with ferrous castings.

Mr. Cook said that in the case of the large foundries the testing was done at a given point. This could not be done in a small foundry. The decision was left entirely to the skill of the moulder, and his knowledge of how to determine the right condition of the sand. The moulder could tell by the "feel" to a very great extent.

Dr. Fell thought it might be an advantage to have a machine for testing permeability, thus tending to eliminate any possible human error.

Thermo Couple Protection

Mr. Turner asked what type of cover Dr. Fell used for his thermocouples and what was the least time lag in taking temperatures.

Dr. Fell said that if suitable sheaths could be got they should increase the life of the couple, though the time lag was increased appreciably as compared with the use of bare couples, or of couples given a light coating or protective wash consisting of refractory material.

Mr. Flowers said that some years ago he was considering a method of melting steel by the high-frequency furnace. During the course of his investigations he asked a prominent non-ferrous foundry industrialist why it was not possible to melt aluminium and aluminium alloys by the high-frequency method which would obviate 99 per cent. of the difficulties of the present system with oil. The reply, at that time, seemed to be something of a paradox. If it were possible to melt steel in a high-frequency furnace to over 1,600 deg. C. and he was told also that it was not practicable to melt aluminium in the same furnace at about 700 deg. C., then it did seem to be a paradox. It was understood that some aluminium foundries at the present time were using a low-frequency furnace but not from an actual melting point of view, merely for the purpose of dissolving the aluminium in a bath which was already formed. What was Dr. Fell's view of future possibilities of melting light alloys in such a furnace?

Dr. Fell replied that he had little up-to-date experience in this matter.

Crack Detection

Mr. D. Fleming remarked that the opinion had been expressed that the fluorescent method depended upon surface tension. A word of warning ought to be given with regard to the employment of fluorescent light detection of cracks that a minor crack was not always clearly discernible.

Dr. Fell was interested in the remark that a very fine crack might not be detected by fluorescent methods, though he could not say whether this would be so. Nevertheless, the method was very sensitive, and a trained inspector used to the work could detect very fine cracks. It was not within knowledge as to whether a very fine crack could escape detection owing to surface tension effects in the fluorescent method, though, of course, this might possibly be the case. Even with radiographic technique the investigator might fail to discover a fine crack because it did not usually lie, as it were, in a plane. If the rays were in the right position it would stand more chance of being detected, but the crack usually assumed a zig-zag course, and even with the rays in the most favourable position it might be missed entirely.

Mr. F. Beet said that radiography would disclose a defect in up to about 2 per cent. of the thickness of the metal when in direct line with the rays, and perhaps would, actually, up to about 5 per cent.

The proceedings then concluded.

BRITISH RESOURCES OF STEEL MOULDING SANDS

IRON AND STEEL INSTITUTE REPORT

The Iron and Steel Institute has now issued as a preprint "British Resources of Steel Moulding Sands—Parts 6 to 10." It is a report of the Steel Castings Research Committee, prepared by Dr. W. Davies and Dr. W. J. Rees.

PART 6—The Sand Deposits Associated with the Lincolnshire Wolds.—These sands occur within easy reach of the foundries of Yorkshire, Derbyshire and Nottinghamshire. The sands may be divided into two groups: those of recent age and those of the lower cretaceous age. Both types are suitable for use as silica sands; those of recent age are similar to the sands of Southport and Chelford, while those of lower cretaceous age resemble certain of the Leighton Buzzard sands.

PART 7—The Quartzitic Grits and Sandstones of Nidderdale and Wharfedale.—The beds of friable, white quartzitic sandstone which are exposed in the vicinity of Nidderdale and Wharfedale are of interest as a source of high-silica sand. They are fairly close to the foundries of Yorkshire and Tees-side. The physical characteristics of the crushed sandstones vary along the outcrops; at some exposures the gradings are comparable with those of certain of the Leighton Buzzard sands, while at others they resemble that of Chelford sand. The quartzitic grits and sandstones of Greenhow Hill indicate the possibilities of this hitherto unused source of high-silica sands. Some of the crushed rocks, especially when washed, are suitable for use as glass sands. Their gradings are comparable with those of high-silica sands used in steelfoundries, but the grains are much more angular; this latter feature may cause difficulties in some types of foundry practice.

Quartzitic Sandstones

PART 8—The Quartzitic Sandstones in the Cefn-y-Fedw Series of North Wales.—The quartzitic sandstones in the Cefn-y-Fedw Series of North Wales vary in texture from open to compact. Those with an open texture can be crushed easily and yield a well-graded high-silica sand. Those with a compact texture do not crush easily and yield mixtures of coarse, angular particles and very fine particles, that is, the characteristics desirable for silica-brick manufacture. Certain of the quartzitic sandstones of the Cefn-y-Fedw Series, when crushed and milled, yield well-graded high-silica sands, composed of angular quartz grains. The most suitable sandstones are even-grained and friable; their texture is open and they are composed almost wholly of quartz. As their texture becomes more compact, the crushed rock becomes less well-graded and the proportion of very coarse and fine particles increases until a grading is obtained more suited for silica-brick manufacture than for high-silica sands for foundry use. The high proportion of strained grains will produce a rather high proportion of fines in a sand system.

PART 9—The Rotten-rock Moulding Sands of Durham and South Northumberland.—The tentative conclusions drawn in the preliminary account given in Part 4 of this Paper are confirmed and extended. The detailed properties of the rotten rocks from 17 localities are recorded. Comparisons drawn from these data and from foundry trials show that a bond composed of moderately or strongly pleochroic hydrobiotite is preferable to one composed of slightly pleochroic hydrobiotite or of sericite. Rotten-rock moulding sands suitable for use in steelfoundries are exposed at many localities in the Fell country of Durham and south Northumberland. Most of these rocks are composed of quartz and secondary mica, though some contain felspar or kaolinite in addition. The secondary mica varies in composition; in some rocks most of the mica is strongly pleochroic, probably because of its high iron content, and may be referred to the hydrobiotite group. Progressively less pleochroic varieties predominate in the other rocks examined. In some of the rocks the mica shows little or no pleochroism and may be referred to the sericite group.

An Important Distinction

This distinction is an important one, for the moulding characteristics of the sands are closely related to the constitution of the bonding minerals. Sands bonded with the more pleochroic varieties of hydrobiotite are to be preferred to those bonded with the less pleochroic varieties or with sericite because:—(1) The gradient of their green-strength/moisture curve is more gentle, that is, their green strength is less sensitive to variations in moisture content; and (2) their refractoriness is slightly lower, so that, under certain conditions, they may form a slagged layer against the casting; this layer strips readily and imparts a smooth skin to the casting.

PART 10—The Rotten-rock Moulding Sands of the Midland Valley of Scotland.—A brief account is given of the moulding characteristics of several typical Scottish rotten rocks. Their characteristics are similar to those of the Durham rotten rocks. In one sample, the bond has been reduced to kaolinite; such advanced weathering reduces the strength markedly. The moulding characteristics of these Scottish rotten rocks are in accord with those of the Durham rotten rocks described in Part 9. The Carlops rock presents an extreme case of "rotting" and shows that, so far as the strength properties are concerned, such complete alteration is not desirable.

WELDING OF NICKEL-ALLOY STEELS

Low-alloy nickel steels may be welded successfully by any of the commercial processes. The actual welding operation, states T. N. ARMSTRONG in an article in "Iron Age," January 24, 1946, thoroughly exploring the subject, differs little from that used for mild-carbon steels except that it must be taken into account that alloy steels possess greater hardenability than plain carbon steels of the same carbon content. In welding processes such as metal-arc and electrical-resistance, the tendency to develop high hardness in the area adjacent to the weld must be controlled by such methods as preheating and postheating if the steel has much hardening power. Necessity for such control obviously occurs with lower carbon content in the alloy steels than in the plain carbon steels.

HEAT-RESISTING ALLOYS FOR MOTOR-CAR GAS PRODUCERS

Details of experiments undertaken to improve the "life" of gas producer castings

By J. SISSENER, Oslo*

Just before Norway was occupied by the Germans in 1940 the use of petrol for private cars and lorries was prohibited. Thus gas producers running on wood were installed. One of the most popular gas producers was based on the Imbert system, as applied by General Motors International, of Oslo. The part where the combustion takes place is called the hearth. The air enters through several small inlets into the main centre, where descending wood is converted to CO gas.

Temperatures as high as 1,300 deg. C. were registered in the middle, and the hearth was sometimes twisted and deformed, indicating a temperature exceeding the softening point of the alloy. In spite of being heated to such a high degree, practically no scale was formed when the parts were of an appropriate composition, that is a chromium content above 25 per cent. A sheet-iron cylinder was welded on to the hearth, the latter was also machined inside and proved to be gas-tight. When the combustion had proceeded for a while, the CO became partly decomposed to C and CO_2, according to the equation $2CO = CO_2 + C$, and carbon was formed in the centre. In short, the essential requirements are:—(1) To withstand a temperature of 1,100 to 1,200 deg. C. in an atmosphere of CO gas in a bed of incandescent carbon; (2) ability to be welded on to ordinary sheet iron without heat treatment, and (3) machinability. At first, an alloy of 25 per cent. Cr and 20 per cent. Ni was successfully used, but soon had to be abandoned on account of the shortage of nickel. Could a straight ferritic 25 per cent. chromium steel be used? This was an open question. Practically all civilian cars and trucks in Norway were out of commission. The following conclusions were drawn:—(1) The hearth will pick up some carbon, but not very much. Chromium has a great affinity to carbon, but is in its solid phase, and the gas is mixed with nitrogen and hydrogen. Actually later tests showed a carbon pick-up from 0.02 to 0.03 per cent.; (2) quite definite statements as to whether a ferritic 25 per cent. chromium steel without nickel could be used had to be tried out in practice. It was probable that this alloy would satisfy, being of good heat resistance, and it was not so liable to crack, having a lower coefficient of thermal expansion than the 25 per cent. Cr, 20 per cent. Ni alloy. However, the higher nickel alloy was much stronger and tougher.

Limiting Temperature of Heat Resistance

Experiments on a small scale were started in order to find out the limiting temperature of heat resistance. Small pieces of 25 per cent. chromium steel were placed in a crucible, and this was put into an electric furnace. The crucible was also of 25 per cent. chromium steel. Between the samples were placed small pieces of charcoal. CO gas was formed by conducting air through the incandescent charcoal at 1,000 deg. C. and then led into the crucible. The furnace was heated for 168 hours to 1,200 deg. C. In this atmosphere and by this temperature few satisfactory results were obtained with 25 to 29 per cent. chromium-steel samples. The next trial was therefore conducted in another way. In the crucible was placed a small disc and on this, the samples, among small pieces of carbon. The same gas was led in at the bottom and out at the top. After 576 hours' heating at 1,100 deg. C., all samples were taken out. These are shown after test in Fig. 1. They all stood up excellently. The composition and loss or gain in weight of the various samples are shown in Table I.

TABLE I.—*Trial No. 2—576 Hours at 1,100 deg. C.*

Sample No.	C	S	Cr	Ni	N_2	Percentage change in weight.
1502	0.57	0.46	25.5	3.39		− 0.170
1511	0.58	0.42	28.4	1.91		− 0.090
1471	0.67	0.40	27.4	1.66		+ 0.080
185	0.59	0.35	27.2	3.04	0.21	+ 0.080
1474	0.66	0.35	26.9	1.91		+ 0.016
173	0.38	0.44	24.2	12.70		− 0.060

The temperature was then raised to 1,150 deg. C., but without carbon in the crucible, and kept at this temperature for 264 hours. This trial also gave good results, as shown in Table II, but not such good results as trial No. 2. Evidently 1,150 deg. C. is the limit to which 25 per cent. chromium steel can be heated in CO gas. At the same time, the crucible where the outer surface was heated in an oxidising atmosphere stood up exceedingly well.

TABLE II.—*Trial No. 3—254 Hours at 1,150 deg. C.*

Analysis.						Percentage change in weight.
C	S	Cr	Ni	N_2	Mn	
0.67	0.40	27.4	1.66			− 0.043
0.59	0.35	27.2	3.04	0.210		− 0.220
1.00	0.35	27.6	2.72			− 0.170
0.58	0.42	28.4	1.91			− 0.080
0.83	0.44	27.1	2.53	0.205	4.95	+ 0.980
0.57	0.46	25.5	3.39			+ 0.070
0.59	0.42	27.8	2.45			+ 0.550
0.48	0.35	26.0	2.47			− 0.060

Carbon up to 2.8 per cent. lowers the melting point of the 25 to 30 per cent. chromium steels. High carbon also adversely affects the welding operation

* The Author is Secretary of the Norwegian Foundry Employers' Association.

Heat-resisting Alloys

and makes the joint brittle. The same effects result from the use of high silicon, although it makes the alloy more fluid when molten.

After these preliminary trials, the risk was taken and production started, with encouraging results for 4 years, during which time some cars even covered 40,000 miles without changing hearth. The company had available two furnaces, a Detroit Rocking furnace, 1,500 lbs., and a Rennerfelt furnace, about 2,400 lbs. capacity.

Typical analysis for the 25 per cent. chromium steel is given in Table I. Carbon should be kept as low as possible around 0.30, with silicon as low as possible, with nickel about 2 per cent. and nitrogen 0.20. This gives, without heat treatment, a tensile strength of about 38 tons per sq. in., with an elongation of 2 per cent.

Welding Details

The structure is coarse grained, but much depends on the casting temperature. The welding to the sheet iron without preliminary heating is carried out with very soft plain iron electrodes, containing 1.20 to 1.70 per cent. manganese. Low current density and + polarity 3.25 mm. rod is used.

It is hoped that this brief account of the use of 25 per cent. chromium steel will be of interest to producers of the same alloy abroad, since this is a first-hand practical trial of this alloy on a really large scale, amounting to several hundreds of tons of heat-resisting castings.

Substituting Aluminium for Part of the Chromium

As the war came to an end the stocks of ferro-chromium ran short, and it was wondered whether aluminium could replace chromium in heat-resisting steels. Various patents have been issued on this subject, and a list of these and of one publication is given as an appendix. The greatest difficulty lies in the fact that aluminium bestows brittleness upon the steel. An addition of 3 to 4 per cent. makes it scale resistant to 1,000 deg. C., and when the content is raised to 6 per cent. Cr and 6 per cent. Al. the alloy is supposed to be able to withstand 1,200 deg. C. (Stahl und Eisen No. 62, 1942.)

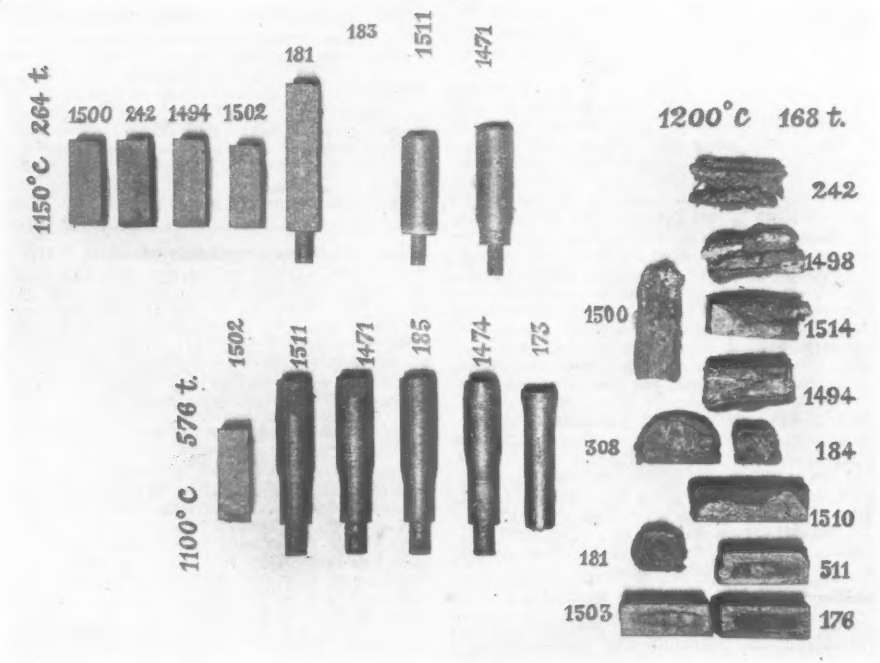

FIG. 1.—SHOWING RESULTS OBTAINED WITH 25 PER CENT. Cr STEEL AFTER 576 HRS. AT 1,100 DEG. C.

Cast iron can also be alloyed with aluminium to make it heat resistant, but at the same time renders it very brittle. It is reported that 7 per cent. Al together with small percentages of chromium are sufficient to give a heat-resisting cast-iron alloy. This alloy will withstand 900 deg. C., and is sold in England

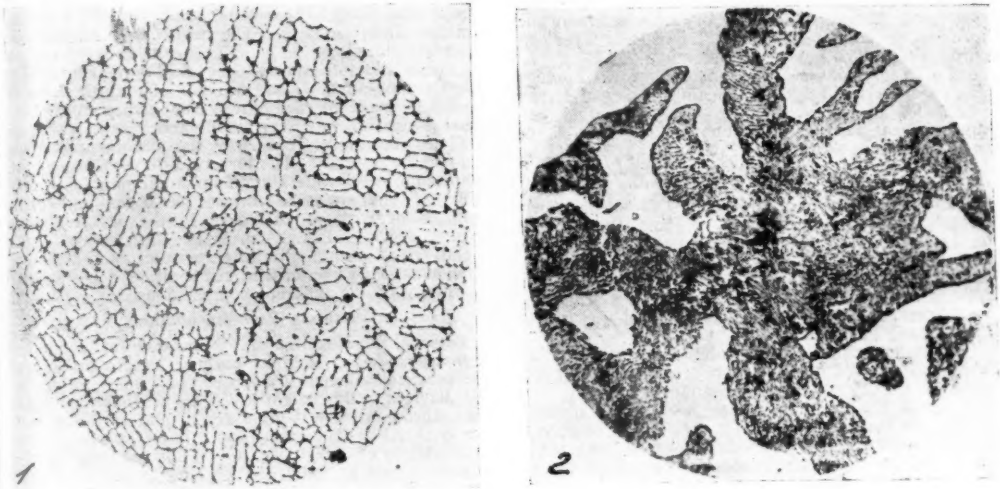

FIG. 2.—MICROSTRUCTURE OF 1104 AL (C, 0.62; CR, 19.8; AND AL, 3.30 PER CENT.), SHOWING CHROMIUM FERRITE WITH A NETWORK OF CARBIDES. NO. 1 IS × 50, AND NO. 2, × 400.

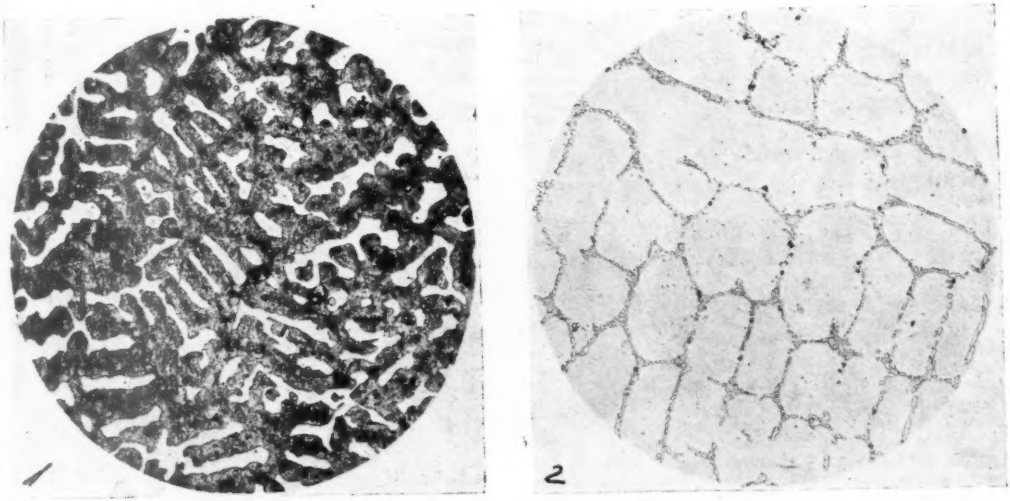

FIG. 3.—MICROSTRUCTURE OF 7 PER CENT. CR, 3.85 PER CENT. AL STEEL; SHOWING PEARLITE IN A FERRITIC MATRIX.

Heat-resisting Alloys

under the name of "Cralfer" (British Patent 489,936). It will resist in the ratio 7:1 as compared to ordinary cast iron. Reports came in from Denmark where they used hearths composed of iron alloyed with 5 per cent. chromium and 2 per cent. aluminium. Welding was done after previous heating, but nothing was disclosed as to the average life of the castings in actual service. In Sweden a very well known alloy, "Kantal," gave superior heat resistance. It contained around 25 per cent. chromium, aluminium, and some cobalt.

Influence of Aluminium on Chromium Steel

How does the aluminium influence the structure of the 25 per cent. chromium steel? No small experimental furnace was available. From the 750 kg. rotary electric furnace was tapped a crucible of 25 per cent. chromium steel. The crucible was of graphite, preheated, and with a known weight of molten aluminium in its bottom. It was placed on a scale, and a predetermined weight of chromium steel was poured into it until the scale went to balance.

Carbon tetrachloride was used as a de-oxidiser. Small additions of aluminium had a very remarkable effect on the 25 per cent. chromium-steel alloy, and 1.34 per cent. of Al lowered the mechanical strength to $\frac{1}{4}$ of its original value. The grain was coarsened but the machinability improved. However, the castings could not, owing to the brittleness, be welded to the sheet iron in the usual way. After welding they all showed several small cracks. It was hoped that these difficulties might be overcome when the chromium content was lowered so much that the "mother alloy" would fall into the martensitic-ferritic groups of alloys with better mechanical properties. Thus an unmachineable strong alloy containing 0.62 per cent. carbon and 21.5 per cent. chromium was cast and alloyed with 3.30 per cent. Al. The hardness dropped from Rockwell 36-38 (Brinell about 340) to Rockwell 19-23 (Brinell 235), and showed remarkably good machining properties. The strength dropped at the same time to $\frac{1}{4}$ of the original value, and the deflection on the same test to $\frac{1}{6}$. The hearth cracked, however, during welding.

These attempts showed the futility of proceeding along these lines. No hearths of industrial value could be made of such brittle composition even if the heat resistivity was very good, and a radical change had to be made. Evidently the chromium content had to be lowered. The structure of the 20 per cent. chromium steel with aluminium addition is shown in Fig. 2. The structure consists of chromium ferrite with a network of carbides. In the U.S.A. Patent No. 1,850,953 P.A.E.Armstrong describes a series of alloys of aluminium and chromium, and curves are drawn showing the critical temperature for the heat resistivity of the different compositions.

Author's Recommendations

Personal investigation has been only of a supplementary character, and its purpose was to investigate the practical value of a given composition. Following the diagram in this Patent it was shown that with 3 per cent. chromium it was necessary to add as much as 6 per cent. Al to make the alloy suitable to withstand a temperature of 1,000 deg. C. But as long as the Author aimed at 1,100 deg. C. he still put in a little more and made up the alloy to 7 per cent. Al with 4 per cent. Cr. This particular composition has not been investigated by Mr. Armstrong, 6 per cent. being the limit he used. The melting was done in a special electric rotating furnace of the carbon-resistor type, or 85 lbs. capacity. A charge of scrap steel, ferro-chromium and ferro-silicon was melted and then poured into a pre-heated graphite crucible, containing the

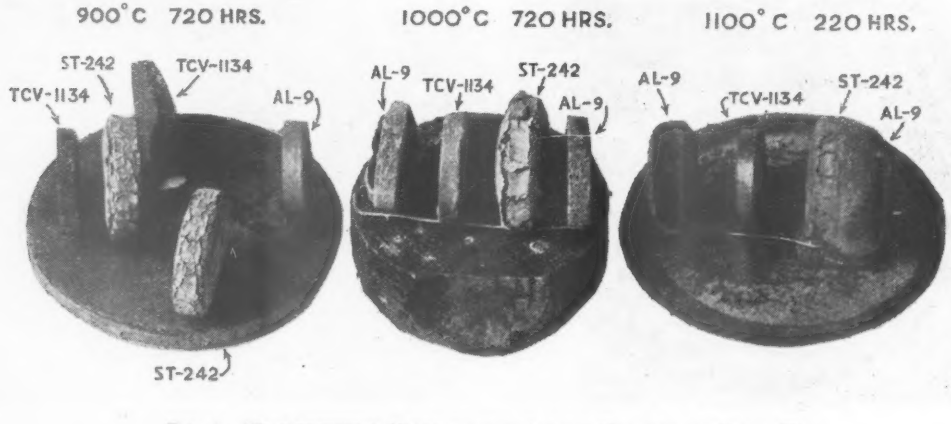

FIG. 4.—HEAT-RESISTING TESTS ON THE ALLOYS DETAILED IN TABLE III.

molten aluminium. The slag was made up of 1 part fluorspar and 1 part of dolomite capable of taking up the Al_2O_3 formed. Carbon tetrachloride was used as a deoxidiser. This liquid was absorbed in cotton, and then charged with a rod in the crucible. After several trials the Author at last succeeded in obtaining the desired composition, and cast test bars and one hearth from this heat. The analysis showed 7 per cent. Cr., 3.85 per cent. Al, 0.56 per cent. C, and 0.83 per cent. Si. Loss of aluminium in the slag was only 4 per cent. The test bar showed a very coarse-grained structure with a hardness of 22 Rockwell and a tensile strength of 11 tons per sq. in., with no elongation at all. Trials to improve the structure by heat treatment were undertaken, but did not give any result. The structure is shown in Fig. 3 in the cast condition.

In order to be able to obtain a safe welding the casting was pre-heated, and in this way a trial hearth

TABLE III.—*Behaviour of Cr–Al Alloys at Elevated Temperatures (see Fig. 4).*

1. 900 *deg. C. Temperature*, 720 *Hours Heating.*

	Percentage change in weight.
T.C.V. 1134	+ 0.47
T.C.V. 1134	+ 0.33
Al 9..	+ 1.45
St. 242	+40.38
St. 242	+39.87

2. 1,000 *deg. C. Temperature*, 720 *Hours Heating.*

	Percentage change in weight.
T.C.V. 1134	+ 6.40
Al 9..	+17.00
Al 9..	+ 6.60
St. 242	+40.44

3. 1,100 *deg. C. Temperature*, 220 *Hours Heating.*

	Percentage change in weight.
T.C.V. 1134	Nil
Al 9..	47.43
Al 9..	
St. 242	Completely destroyed.

St. 242 is an ordinary cast-iron containing C 3.80; Si 1.50; P 0.80; and S 0.08 per cent. T.C.V. 1134 is an alloy containing C 0.63, and Cr 21.5 per cent. Al 9 is an alloy containing Cr 7.0; Al 3.85; CO 56; and Si 0.83 per cent.

was successfully obtained. After a successful weld the gas producer was mounted on a truck, and served well for 10,000 miles, when it was taken out and showed some scale formation on the surface. The interesting part lies also in the tests carried out in the laboratory in order to find out the heat resistivity as compared with 25 per cent. chromium steel. These trials were carried out at 1,100 to 1,200 deg. C. and for simplicity in an oxidising atmosphere. The alloy would not stand this temperature, as proved in Fig. 4. The temperature was lowered between 1,000 and 900 deg. C., and the samples kept at these temperatures for 30 days. It is probable that 900 deg. C. is the critical temperature for 7 per cent. Cr, 3.85 per cent. Al, 0.5 per cent. C alloy, which is shown in Fig. 4, and made clear from the figures given in Table III.

The superiority of the chromium steel over the new alloy is also quite evident. However, it must be taken into account that the Cr:Al alloy is a cheaper composition. The relation of heat resistivity is nevertheless 27 times that of cast iron, but ¼ to ⅓ that of the chromium steel at 900 deg. C. The alloy has a remarkable tendency to grow, possibly on account of the relatively high carbon content. This will have to be examined in detail in the future.

Conclusion

The 25 per cent. chromium steel with 2 per cent. of nickel, or 0.3 per cent. of nitrogen, has been successfully used for hearths on gas producers for lorries and motor cars during the war in large numbers. A new alloy, about 7 per cent. Cr, 4 per cent. Al and 0.5 per cent. C, is also heat resistant, but mechanically brittle and not so resistant as the 25 per cent. chromium steel. It is, however, far superior to cast iron. Sincere thanks are given to the Christiania Spigerverk, and to the Geological Museum of Oslo for valuable assistance in conducting experimental work.

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Stahl und Eisen Nr. 19 (1942), F. Schulte: "Der derzeitige Stand des warmfesten und hitzbeständigen Stahlgusses."

ESSENTIAL WORK ORDERS

Since writing a leading article on this subject, the matter has been investigated by the Council of Ironfoundry Associations, and they, like we, have found the results to be somewhat chaotic. Primarily, not all foundries have been scheduled; secondly, opinion is divided as to the desirability of the continuation of the application of the Order, and finally all ironfounders are agreed that the Order should be either universally applied or totally withdrawn.

Moreover, in at least one case, an important company—a large foundry concern engaged on repetition castings, was de-scheduled, whilst its subsidiary, also manufacturers of castings housed in shops within the framework of the parent organisation, was scheduled! In view of such conditions steps were immediately taken by the C.F.A. to ensure uniform treatment of the whole industry and it can now be revealed that the Government has decided to remove ironfoundries from the list of industries scheduled under the Essential Work Orders.

CORRESPONDENCE

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Tellurium in Cast Iron

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—We read with interest the Paper in the FOUNDRY TRADE JOURNAL of March 14, headed, "Some Initial Results on the Influence of Tellurium as a Chill-Inducing Medium on Cast Iron." The Author is to be congratulated on the excellently clear manner in which he has presented his facts. His studies on the effect of varying casting temperature on the chill depth are particularly valuable.

It may be of interest to your readers to know that we are the owners of a Patent, granted in 1938, covering the use of tellurium as a chill-inducing medium and methods of control of the resultant depth of chill. This extensive Patent was the result of large scale experiments carried out during the years 1936 to 1937.

Contrary to the Author's experience the effect of the chilling can be controlled without the fluctuating results described in his Paper. The following may be of some interest. Blocks 2 in. by 2 in. by 4 in. were cast in a standard grey iron (phosphorus, 0.15 per cent.) without tellurium additions and with tellurium.

	Brinell Hardness Number.	
	Corner.	Centre.
Standard grey iron	207	207
Plus 0.0025 per cent. of Te	370	370
„ 0.005 „ „	437	437
„ 0.025 „ „	437	437
„ 0.05 „ „	437	437
„ 0.10 „ „	437	437
„ 0.2 „ „	415	415

The phosphorus content, it will be noted, could not be described as high, yet the chilling effect was even throughout the whole section. The description of the method of controlling the hardening effect of tellurium so that the hardness is localised to a particular part of the casting suggests that this method is rather more complicated than is absolutely necessary. It may be of interest that in our Patent we have established a much simpler method of achieving localised hardness giving Brinell of the order of 450 to 500 and at the same time gaining a toughening effect for wear resistance. Cams and colliery tub wheels are examples of the application of these results.

Mr. Sumner states that in his foundry the use of tellurium as a densener for pressure resistance castings has proved successful in reducing the number of "leakers" under water test. It is true that tellurium is successful for such purposes used in the method stated, but we are surprised to learn that he finds it necessary to have recourse to such methods of achieving pressure-tight castings. Modern high-duty iron standard practice has proved that complicated pressure cylinder castings can be made absolutely pressure tight up to 3,000 lbs. per sq. in. as a matter of ordinary production. In certain special cases pressures of the order of 6,000 lbs. per sq. in. to 10,000 lbs. per sq. in. have been achieved with standard type Meehanite metal without alloying, densening or recourse to complicated methods such as the Author describes.

Yours, etc.,
For the International Meehanite Metal Co., Ltd.,
W. FINDLAY SEIVEWRIGHT,
Manager, Development and Publicity Dept.
March 19, 1946.

66, Victoria Street, London, S.W.1.

[We sincerely regret that we omitted to print that the Paper was written by Mr. A. N. Sumner, the honorary secretary of the East Anglian Section of the London Branch of the Institute of British Foundrymen.—EDITOR.]

Banded Structures

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have read with great interest in your issue of the FOUNDRY TRADE JOURNAL of February 21, the article on "The Formation of Banded Structures in Horizonal Centrifugal Castings," by Mr. C. Howson. Might I please submit the following question? Has Mr. Howson considered the possibility of introducing the metal into the horizontal mould in such a way that it acquires an angular velocity equal to that of the mould before it actually enters the mould itself?

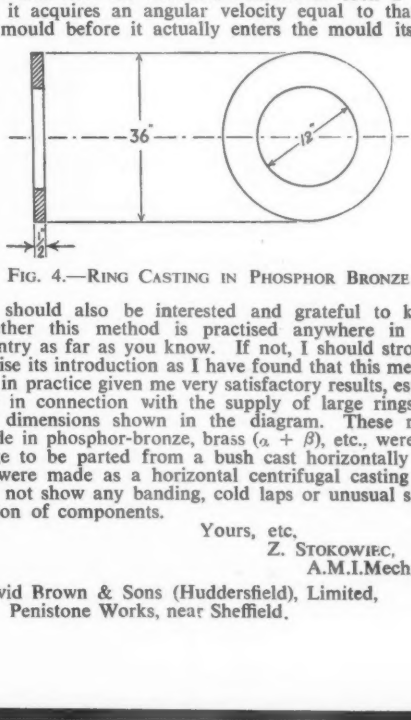

FIG. 4.—RING CASTING IN PHOSPHOR BRONZE

I should also be interested and grateful to know whether this method is practised anywhere in this country as far as you know. If not, I should strongly advise its introduction as I have found that this method has in practice given me very satisfactory results, especially in connection with the supply of large rings for the dimensions shown in the diagram. These rings, made in phosphor-bronze, brass ($\alpha + \beta$), etc., were too large to be parted from a bush cast horizontally and so were made as a horizontal centrifugal casting and did not show any banding, cold laps or unusual segregation of components.

Yours, etc,
Z. STOKOWIEC,
A.M.I.Mech.E.

David Brown & Sons (Huddersfield), Limited,
Penistone Works, near Sheffield.

A.F.A. JUBILEE CONGRESS

TENTATIVE PROGRAMME

An Institute of British Foundrymen exchange Paper, "Production of the Tall Boy and Grand Slam Aerial Bombs," by Mr. Basil Gray, special director, English Steel Corporation, Limited, will be a feature of the Golden Jubilee Foundry Congress and exposition of the American Foundrymen's Association in Cleveland, Ohio, May 6-10.

Mr. John W. Gardom and Mr. Tom Makemson, M.B.E., President and Secretary, respectively, of the Institute, will head the British delegation to the Congress, expected to be the largest in the Association's history. Their party, which will include Mr. Basil Gray, plans to arrive in New York City about April 21 for a pre-convention tour of foundries in a number of America's eastern and mid-western cities.

Sizable delegations to the congress are also expected from Canada, Mexico and South America, where the A.F.A. has a large and growing membership, and from Australia, France, Belgium, Sweden, Norway, Russia and China.

In more than sixty technical and general interest sessions the five-day conclave will reveal and fit together wartime developments, and discuss research, operating techniques, shop practices, job training, costing, engineering properties, controls, and educational projects as steps in improving castings quality and accelerating production for peacetime uses.

A Special Session

"Foundry Control Methods" will be the subject of a five-session lecture course expected to attract wide attention. Speakers will discuss control methods for aluminium and magnesium, brass and bronze, malleable, steel and grey iron foundries. Cognisant of the broad scope of the subject, the Association's Annual Lecture Committee plans to continue the series throughout the 1947 convention and, later, to make the material available in book form.

A sand shop course is also scheduled for each of the five days of the conclave. It will deal with sand control in the casting of bronze, grey iron, malleable iron and steel, and feature a Paper on magnesium moulding sands. Foundry sand research will be covered in two sessions, one of which will present a progress report, the sixth, on the investigation of properties of foundry sands at elevated temperatures. Heat absorption of sands and "The A.F.A. Clay and Fineness Determination" will also be discussed.

Centrifugal casting, dimensional stability, heat treating, microporosity, effect of mould materials and recommendations in the matter of aluminium and magnesium moulds are to be discussed at sessions programmed by the Association Aluminium and Magnesium Division. The Brass and Bronze Division topics include knock-off risers, use of insulating pads for riser sleeves, combustion for crucible melting, methods of sealing through heat treatments, and distribution of mechanical properties in sand cast bronzes.

Australian Participation

The initial Paper to be submitted by the Institute of Australian Foundrymen in an exchange series similar to the A.F.A.-I.B.F. series will be presented at one of the brass and bronze sessions. Prepared by Mr. H. E. Arblaster, chief metallurgist, Stokes & Sons, Melbourne, the Paper will deal with magnesium bronze and standards of its production in Australia.

Two of five sessions scheduled by the Grey Iron Division will be concerned with engineering properties; a third will consider welding of grey iron, and the others will be more general in character. Wear resistance, relationships between section size and mechanical properties and between hardness and tensile strength, heat treating, fatigue limit and notch effect are among subjects scheduled for discussion. Grey iron shop course sessions have as their topics metallurgy of cupola mixes, carbon control in the cupola, and castings defects attributable to metal.

Russian Papers

Sessions of interest to malleable foundrymen will have core practice as their major topic. Coremaking in motor-vehicle shops and large mechanised foundries will be thoroughly covered, and attention will also be directed to malleable iron chemistry, melting, test-bars, and sulphur-manganese ratios. Steel symposia subjects are, thermal relief of stresses, heat-treatment, blind risers, low temperature properties, bore cracks in valves and fittings, and steel production for castings. Russian technicians will discuss "The Technological Principles of Casting Design," and "The Susceptibility of Steel and Hot Tear Formation in Castings."

Accident prevention, viewed as an important management function; inspection of castings; cost accounting, discussed from the standpoint of the jobbing foundryman; apprentice training and "human relationship" problems; patternmaking; refractories; time study and job evaluation, are included in the wide range of management and general interest subjects programmed for discussion.

Presidential Address

Mr. Fred J. Walls, International Nickel Company, Inc., Detroit, President of the Association, will address the annual business meeting of the convention on Thursday, May 9. That session will also feature presentation of the Association's annual awards for meritorious service to, and outstanding achievement in, the foundry industry. The programme also provides for an engineering school alumni luncheon; dinners of chapter officers and directors, foundry instructors, A.F.A. past-presidents, other former officers and directors, and an unusually large number of wide-interest round-table luncheons and committee meetings.

The foundry equipment and materials show to be staged in connection with the Jubilee Convention is expected to prove to be the most important, as well as the largest, of its kind ever held in America. Many peacetime products developed to speed castings production for war will be given their first showing.

INDUSTRY AND RESEARCH

The Federation of British Industries' Conference on Industry and Research, held yesterday and to-day at the Kingsway Hall, London, W.C.2, produced a number of addresses by Ministers of the Crown and internationally-known scientists, and a series of papers by eminent leaders in British research work. With the exception of Dr. C. C. Paterson's contribution—"Conversion of the Results of Research into Production," which has practical application—the rest were an aggregation of platitudes salted with excellent illustrations of the results achieved. As space prevents the publication of the papers, a phrase from each has been culled to illustrate directions of and for thought.

DR. J. R. HOSKING (Director of Research and Development, Paint Division, I.C.I., Limited), in "Research Quality":—

"It is well known that a very large proportion, probably as much as 80 per cent., of all ferrous and non-ferrous castings are porous to fluids such as water, petrol, or oil."

MR. A. HEALEY, B.SC. (Director of Production, Dunlop Rubber Company, Limited), in "Research and Production Costs":—

"In industry, the 'old hands,' apt to pride themselves on having no 'scientific education or knowledge' (a mistaken notion, for they have a great deal), have learned much from 'trial and error,' 'rule of thumb,' sweet and bitter experience, and are extraordinarily skilled in their art. The young research worker may be over confident, but if he is honest he will soon come to admire the 'old hand,' while simultaneously finding the problems of industry are not so easy as he expected."

DR. C. C. PATERSON, O.B.E., F.R.S. (Head of the Research Laboratories, General Electric Company, Limited), in "Conversion of the Results of Research into Production":—

"The keeping of a thing under your hat until you are ready to let it burst upon surprised and sceptical colleagues, is not normally good psychology."

DR. R. E. SLADE, M.C. (lately Research Controller, I.C.I., Limited), in "How New Industries Arise":—

"I do not know of a single case of a firm starting a large research laboratory and not making a success of it."

MR. C. H. DAVY, M.I.MECH.E. (Chief Research Engineer, Babcock & Wilcox, Limited), in "Modernisation of Processes and Plant":—

"In recent years research propaganda has tended to stimulate the growth of a conception common among manufacturers that research is associated with and confined within elaborately equipped research stations or laboratories. This idea is quite erroneous and, what is more important, it leads to an entirely false view of the advantages which are to be obtained by applying research to individual process development. A much more ready and eager acceptance of the value and advantage of research would be obtained if the real meaning of the word 'Research' was carried in mind. It has been defined as follows: 'Diligent investigation in order to ascertain something.'"

MR. A. J. PHILPOT, C.B.E., M.A., in "The Part Co-operative Research Can Play":—

"Mountains of difficulty confront industry in the immediate future, but faith in the dynamic power of co-operative research can be a potent agent in their removal."

DR. P. DUNSHEATH, C.B.E., M.A., in "The Firm with a Research Department":—

"The complete specification of the ideal Research Director would carry a long list of characteristics, but above all he should possess energy and inspiration and the ability to engender the same qualities in others. A reasonable modest outlook in dealing with the industrialist of long experience with whom he comes into frequent contact during the course of his work, and a willingness to employ on his staff experts who know far more than he does in particular branches of the different sciences employed, also constitute valuable qualifications."

SIR E. RAYMOND STREAT, C.B.E. (Chairman of the Cotton Board), in "The Firm without a Research Department":—

"You have to recognise something wrong before you busy yourself to put it right."

WASTERS DUE TO DESIGN

By "CORONER"

Not all scrapped castings can be held to be the fault of the foundryman, for there are numerous designs which are almost impossible to manufacture. Despite the protests of the foundryman, the engineer, after having evolved a particular design, is very reluctant to modify it, if it is at all possible to produce. Consequently, the wasters on these particular castings are excessively high and the price should be correspondingly increased to cover such risks. A better policy, however, would be to insist on modification to ensure the production of satisfactory castings at the minimum cost. Numerous examples exist where slight modification greatly reduced the number of wasters.

A particular case concerned a component for a special type forging machine which consisted of a cylinder portion and other members of varying sections, making it practically impossible to ensure solidity in certain internal bosses, and other masses of metal designed to take the shock of forging. A large self-feeder head, placed on the top of an outside boss, failed to keep this job solid in a high-duty iron, and it was only after repeated failure that the designer reluctantly agreed to modify the outside shape, so as to facilitate the placing of a riser of adequate dimensions satisfactorily to feed all the internal masses, through which numerous parts were drilled, and were required to be pressure tight.

Whilst designers are perhaps more ready to agree to modification now, than, say, a generation ago, it still behoves the foundryman to keep on with the good work of educating the engineer to the limitations of the material he is using, rather than attempting to produce an article which is costly and of doubtful reliability, and which tends to increase the number of wasters due to design.

CONTROL OF DOMESTIC HEATING APPARATUS*

A New and Practical Method is described for the Acceptance Test of Solid Fuel-Fired Stoves

By SERGE BOITON

The only factors which have influenced users in the choice of a heating apparatus have been price and appearance. As for efficiency, they merely take the advice of the salesman. Obviously, manufacturers naturally devoted their attention to price and appearance. The consequence of this policy was that a great number of these stoves, commonly sold before the war, and of which the reputation was established by wide and costly publicity, had a thermal efficiency of less than 50 per cent. The increase in efficiency by the improvement of quality has been for several years imposed with the dual object of added comfort and a maximum national conservation of fuel. From the viewpoint of the user, increased efficiency brings about a worthwhile economy; if, for example, one takes the case of a kitchen stove which consumes 33 lbs. of coal daily, and is capable of yielding 7,800 calories in an apparatus with an efficiency of 75 per cent., then the daily economy is 9 lbs. To this is to be added the flexibility and ease of control of the newer types of apparatus. Without trying to guess the economy brought about within the national fuel economy plan by increase in the efficiency of stoves, one can, however, stress its major importance by relating it to the normal French consumption of coal for domestic purposes, which was of the order of 14,000,000 tons annually, of which a large part was burnt in stoves.

Manufacturers' Organisation

The French manufacturers of heating apparatus are organised for their own, and for the national good, as the Union des Fabricants d'Appareils de Chauffrage Domestiques (U.F.A.C.D.). In 1943 they decided to sell only high-grade stoves. They have voluntarily imposed a technical ruling designed to eliminate all apparatus which primarily does not give to the user a security guarantee, and secondly, does not give an efficiency at least equal to 70 per cent.

The Centre Technique des Industries de la Fonderie (national research organisation) has been equipped to carry out the official tests of these apparatus, as a result of which a certificate is issued to the manufacturers. Thus, in 1943, there was created a laboratory specially equipped for the control of domestic heating apparatus to conform with the rulings made by the U.F.A.C.D.†

Testing Methods

The method used for testing the apparatus consists of the establishment of a simple thermal balance-sheet, where, figuring on the debit side, are the calories charged into the apparatus; and on the credit side, the diverse losses—such items as the sensible heat of the waste gases; the latent heat of the waste gases; and the latent heat of the unburnt solids.

The heat dissipated into the room—the major factor on the balance-sheet—is determined difference.

The apparatus are tested with the following rates in view:—(1) There is the normal dissipation into the atmosphere of 43,000 calories per hr. per sq. metre of surface to be heated; (2) the slow dissipation into the atmosphere of 1,000 calories per hr. per sq. metre; and (3) the rapid dissipation of 6,000 calories per hr. per sq. metre of the surface to be heated.

The definition of the normal rate which has to be postulated appears to centre around practice and custom. The slow and rapid rates are simple, deduced from the normal rate.

The tests for the normal rate, which start the cycle of tests, are directed towards the determination of the efficiency of the apparatus. The tests for rapid rates of burning, which follow, are done with the object of testing the life of the materials of construction—particularly the refractories. Finally, the slow combustion tests are carried out. These should, according to the type of apparatus, allow of the continuity of the fire during 12 or 18 hrs. without touching or refuelling, and permit of an appreciation of the fire at the normal rate. A fresh series of tests at normal rate is sufficient to show that the apparatus has not been damaged by test on overload. Thus, the two statements of efficiency (calculated before and after overloading) should coincide within a certain near tolerance.

Testing Procedure

During the conduct of the tests, the apparatus is mounted on a weighing machine sensitive to 20 grammes, which allows one to follow the rate of combustion as a fraction of time. The apparatus is connected to the chimney by an insulated sleeve which branches off the various measuring instruments, and a hydraulic joint allows the weigh scales not only to support the stove, but also the sleeves and the rubber tubes which connect the sleeve to the recording instruments. The chimney draft is maintained at a constant pressure to a predetermined, but variable, figure, for each test. This is regulated automatically by a butterfly valve. The waste gases are analysed every three minutes by an automatic registering apparatus. Based on the Orsat instrument, it records the CO, CO_2, and H_2 contents. The temperature of the chimney gases is shown by a registering thermometer of the platinum resistance type.

*Translated from "Fonderie."

†"Prescription pour la Construction et l'Epreuve des Poêles Métalliques." Published by U.F.A.C.D., 39 rue Copernic, Paris, 16.

Control of Domestic Heating Apparatus

After each test the operator collects the results. The indications of the weighing machine in relation to time give him assurance that the apparatus is functioning exactly at the predetermined rate. He determines the loss through the latent heat of the chimney gases from the results of the recorded analyses, as also the excess of the temperature of the waste gases above the temperature of the surrounding atmosphere, which allows him to express the sensible heat losses of the chimney gases. After that there only remains to find the sensible heat losses of the unburnt fuel by a simple calcination of the contents of the ash-pan. The heat dissipated into the atmosphere is equal to the difference between the number of calories corresponding to the charge into the stove, and the total of the measured losses. Several physical methods based on calorimetric methods, and which should allow of effective measurement of the quantity of heat necessary for heating, have been studied. They introduce some difficulties in application which have brought about their discarding to give preference to chemical methods. In particular, it is deemed impossible to stop tests, either to refuel the stove, or to modify, or regulate its rate of burning without grossly falsifying calorimetric measurements. Such a method would only permit the study of an apparatus over a long period of working. It would thus not be possible to obtain the same constant rate as for a series of hourly charges.

Chemical Method

The chemical method actually used does not take into consideration the thermal balance of elements of a secondary category, such as the sensible heat of combustion and comburent. Experience has shown that there is no real advantage to be gained by taking into consideration these minor details. Moreover, it is of no importance to establish an exact thermal balance-sheet for each apparatus. What is necessary, however, is, above everything else, to find a basis for comparison between the various stoves. The efficiency value, such as is now determined, well represents this basis for comparison. It is, no doubt, very near to the scientific truth, since the factors neglected in the establishment of a thermal balance-sheet have but small importance in relation to the absolute value.

Practical Results

The new technique of construction associated with other recent work has already borne fruit. The laboratory of the "Centre Technique" has already been called in to study a number of new apparatus of various origins. The efficiencies reached for some of these are of the order of 83 per cent. Some stoves of 0.7 square metres (7.5 sq. ft.) heating surface consume when working slowly only 1.5 kg. (3.3 lbs.) of coal in 15 hours' continuous working, without being touched. Moreover, they are capable of working at a normal rate for 8 hrs., only consume 0.5 kg. (1.1 lb.) of coal per hr., and yield to the atmosphere 2,800 calories per hr. These criteria of consumption in relation to time are without doubt the most representative of the progress made, and would appear to be particularly acceptable during a period when there is an acute shortage of fuel, yet they proclaim a future in which research for maximum comfort would be obvious. For instance, in a case where a stove with 7.5 sq. ft. heating surface area installed in a room of 2,470 cub. ft. carrying an outside wall, a stove of this type would heat it, whilst using but 13 to 15 lbs. of coal per 24 hrs., needing attention but twice a day.

The gathering together of figures and curves resulting from the testing of space-heating units constitutes a sure and intelligent guide for the perfecting of technique. In this connection, one might cite the case at the "Centre Technique," where following some tests carried out, a rapid trial was made of two simple dampers for efficiency, a factor of importance in good stoves. Such a research includes the precision setting of the dampness and the 1 to 40 rates between the utilisable surface of the grate and heating surface. These two dampers obviously take pride of place in the brochure published by the U.F.A.C.D.,[1] and circularised to its members, but in truth nothing can show real worth more than tests on a series of apparatus.

Conclusions

The rôle of the "laboratory" as related to the making of domestic space heating units might appear to be above everything else an extra complication piled on top of so many. Yet it is no such thing. It is a simple tool and a very efficient one which is placed at the service of the works development department. This being so, manufacturers can regard the "laboratory" as a decisive element in the future prosperity.

[1]Conseils pour la Construction et l'Epreuve des Poêles Métalliques.

FURNACE BOTTOMS

Examination of lump samples and of drill cores of burned-in and cold-rammed open-hearth bottoms from old and new hearths shows that bottoms of the rammed type do not have as high a density as those of the burned-in type. On the other hand, beating rammed bottoms too thoroughly results in penetrating shrinkage cracks, and cracks due to thermal contraction when the bottom reverts to the temperature gradient under normal operation.—"Steel."

FOR SALE

We have been invited by the Ministry of Supply, hereinafter called "the Authority," to bid for a number of items of plant lying at Central Ordnance Depots at Old Dalby and Bicester. The only items of direct interest to the foundry industry are an oil-fired core oven (4 ft. 8 in. by 3 ft. by 2 ft. 5 in. deep), and a hand squeeze moulding machine (22 in. by 20 in. table). We note with interest that the tender has to reach the Authority by 10 a.m. on April Fools Day!

30 MORE GOVERNMENT FACTORIES ALLOCATED

A further 30 Government factories have been allocated by the Board of Trade to industrial firms in recent weeks. They represent an area of about 4,500,000 sq. ft. and, when in full production, will provide employment for up to 20,000 people. The Board of Trade has also sought agreement with Vickers-Armstrongs, Limited, for the sub-letting of vacant space in the Scotswood factory to Charles Churchill, Limited, for the production of machine tools, and to Aveling-Barford, Limited, for production of builders' and contractors' plant.

In all, 205 Government factories with an area of about 51,000,000 sq. ft. have now been allotted to private industry or to use by the Government for training and research centres and disposals depots. The latest allocations include:—

Jarrow, Baker Perkins, Limited, plant for food and chemical industries.

Birtley, Birtley Company, Limited, refrigerators.

Sherburn-in-Elmet, W. & T. Avery, Limited, weighing machines.

Sheffield, Firth Vickers Stainless Steels, Limited, engine components.

Leicester, Armstrong Siddeley Motors, Limited, engine development.

Stevenage, Vincent-H. R. D. Company, Limited, motor-cycles and marine engines.

Swindon, Plessey Company, Limited, general engineering.

Swindon, Marine Mountings, Limited, light engineering.

Atworth, New Mendip Engineering Company, Limited, pumps.

Salisbury, Wellworthy Piston Rings, Limited, piston rings.

Salisbury, Weir Precision Engineering Company, Limited, machine tools.

Beaumaris, Saunders Shipyard, Limited, sea-going craft and passenger vehicle bodies.

Abergavenny, Coopers Mechanical Joints, Limited, motor-car equipment.

Blythe Bridge, Simplex Electric Company, Limited, domestic electrical appliances.

Wolverhampton, General Electric Company, Limited, carbons.

Radford, Daimler Company, Limited, motor-car parts.

Hereford, Harcourts, Limited, domestic electrical appliances.

Exhall, D. Hinton, Limited, cutting tools.

Preston, English Electric Company, Limited, domestic appliances, traction motors, etc.

Trafford Park, Manchester, Metropolitan-Vickers Electrical Company, Limited, heavy electrical plant.

Openshaw, Williams & Williams, Limited, prefabricated housing units.

Oldham, Foster & Seddon, Limited, Diesel commercial vehicles.

Aberdeen, Tullos, Limited, agricultural machinery.

BRITISH IRON AND STEEL FEDERATION

MR. G. H. LATHAM APPOINTED PRESIDENT-ELECT

Mr. Gustavus Henry Latham has been appointed president-elect of the British Iron and Steel Federation. He will take office next year. Aged 57, Mr. Latham has been a prominent figure in the steel industry for many years. He is a member of the Executive Committee, Council and the Finance Committee of the Federation, and also of the British Iron & Steel Corporation, Limited, of which he is a director. He is also on other committees of the Federation which have been set up under the revised constitution of that body. He is chairman of Conference 13, which covers the section of the Federation dealing with the whole of the finishing products of the steel industry. He is also chairman of the National Association for Rolled and Re-rolled Steel Products and chairman of the Executive, Management and Standing Committees of that body.

Born at Stoke-on-Trent, Mr. Latham left school before his 13th birthday. He spent three years with the London & North Western Railway Company and joined the staff of L. D. Whitehead & Company in 1905. He later went into the works and passed through the various departments to gain a thorough knowledge of the industry. Mr. Latham spent 13 years in the works on the development of continuous rolling mills. He was appointed sales manager of the Whitehead Iron & Steel Company, Limited, in 1921. Ten years later he became general manager and deputy chairman. He was appointed chairman and managing director in 1938, following the death of Mr. L. D. Whitehead, the founder of the original company.

At the end of 1939 Mr. Latham was appointed by the Bank of England control committee to be managing director of Richard Thomas & Company, Limited, a position which he relinquished when the committee relaxed its control of the company in July, 1945. When the Finance Corporation for Industry, Limited, was formed to assist in the modernisation and general rehabilitation of industry, Mr. Latham was appointed as technical adviser for the steel industry, and was appointed to the specialised advisory panel of the Corporation.

He was the foundation president of the Newport and District Metallurgical Society, which is one of the biggest technical societies in the country. Mr. Latham is also a member of the Council of the Iron and Steel Institute.

THE "NICKEL BULLETIN" for January-February includes abstracts dealing with temper-brittleness, critical points of nickel-chromium-molybdenum steel, heat-treatment of hypo-eutectoid steels to develop cold-working properties, calculating hardenability from composition, influence of composition on hot working properties and corrosion in hydrofluoric acid alkylation. Copies of the "Bulletin" may be obtained from the Mond Nickel Company, Limited, Grosvenor House, Park Lane, London, W.1.

PERSONAL

SIR WILLIAM PALMER, chief industrial adviser to the Board of Trade, is shortly to retire.

MR. R. H. POWELL has been elected convener of the Technical Committee of the British Laboratory Ware Association, Limited, in succession to MR. S. J. DAVIES.

MR. PERCY P. LEVY will join the board of H. B. Barnard & Sons, Limited, metal merchants and manufacturers, of Glyn Street, London, S.E.11, as from April 1.

SIR SUMMERS HUNTER, managing director of the North Eastern Marine Engineering Company (1938), Limited, has been elected a member of the River Wear Commission.

MR. F. A. GEORGE, director and secretary of William Dickinson & Company, Limited, iron-ore merchants, of Newcastle-upon-Tyne, has been appointed a Justice of the Peace.

MR. ARTHUR ALLAN, who has completed 50 years' service with Lee, Howe & Company, Limited, pump manufacturers, of Tipton, has received a presentation from the firm.

MR. JOHN BROWN, general secretary of the Iron and Steel Trades Confederation, has retired on superannuation, and the executive has appointed MR. LINCOLN EVANS as his successor.

MR. DONALD T. OXTON has been appointed managing director of the Rowhedge Ironworks Company, Limited, Rowhedge, near Colchester, in succession to the late Mr. F. H. Butcher.

MR. E. R. JONES, for some months acting secretary of Ruston & Hornsby, Limited, Sheaf Iron Works, Lincoln, has been appointed secretary, in addition to his duties as chief accountant.

SIR DIGBY LAWSON has been appointed chairman of Fairbairn Lawson Combe Barbour, Limited, engineers and ironfounders, of Leeds, in place of Mr. J. K. Anderson, who has resigned from the board.

MR. JOHN HENRY, who has been elected president of the South African Association of Production Engineers, went to South Africa 12 years ago to take up an appointment as general works manager with Dorman, Long (Africa), Limited, Johannesburg.

MR. C. G. G. BOSWOOD, hitherto secretary and general manager, MR. A. S. GILL and MR. C. E. G. NYE have been elected to the board of George Cohen, Sons & Company, Limited, as special directors. MR. R. S. FERRY has been appointed secretary of the company.

MR. WALTER E. MILLS has relinquished his position as general manager to A. Kershaw & Sons, Limited, precision engineers, etc., of Leeds, but retains his seat on the board. The position has been filled by REAR-ADMIRAL L. E. H. MAUND, who, with MR. R. ROBERTSON, chief mechanical designer, has joined the board.

LORD QUEENBOROUGH, chairman of Siemens Bros. & Company, Limited, has resigned from the board. The managing director, DR. H. R. WRIGHT, has been appointed chairman. MR. F. A. LAWSON, one of the leading executives, has been appointed a director. Dr. Wright, while being appointed chairman, retains his position as managing director.

MR. CHARLES PULLAN, who, for some time past, has been sales manager of the Jarvis Industries group, has been appointed to the directorate of Sir W. G. Armstrong Whitworth & Company (Ironfounders), Limited, Armstrong Whitworth & Company (Pneumatic Tools), Limited, and Jarrow Metal Industries, Limited. He will continue to control the sales organisation of the companies.

Wills

SUMMERS, H. H., of Harrogate, formerly president of John Summers & Sons, Limited, steelmakers, etc., of Shotton, Chester £37,048

BIRCH, H. W., a director of E. Birch & Sons, Limited, iron, steel and wire stockholders, of Wolverhampton and Willenhall £59,746

MR. ANDREW JOLLIE RETIRES

After 50 years' service with the iron and steel industry, Mr. Andrew Jollie has announced his retirement from the chairmanship of the National Association for Rolled and Re-rolled Steel Products. Mr. Jollie, who is chairman of Steel, Peech & Tozer, is also a director of the United Steel Companies, Limited, and was for a time chairman of the National Billet Associations. He took a prominent part in the negotiations in connection with the reorganisation of the industry in 1932-33. At that time Mr. Jollie became chairman of the Co-ordinating Committee set up by the billet makers, heavy-steel makers and independent re-rollers. During the intervening years he played an important part in the industry's inner councils.

Mr. Jollie was the guest of honour at a farewell dinner in London last week. Among those present were Mr. G. H. Latham, who succeeds Mr. Jollie as chairman of the National Association for Rolled and Re-rolled Steel Products, and Sir Andrew Duncan, independent chairman of the British Iron and Steel Federation.

METAL FINISHING ASSOCIATION

At the annual meetings of the London and Birmingham sections of the Metal Finishing Association, the opening of negotiations with the unions for the establishment of a national labour charter for the industry was reported. The Labour Committee was empowered to consider and make recommendations for a scheme for education and training of juveniles entering the industry.

On the technical side, considerable progress was reported in the establishment of standards for various metal deposits, and it will not be long before these standards become the controlling factor of quality in electro-plating practice.

Mr. J. H. Holmes and Mr. W. H. Sawyer were elected chairmen of the London and Birmingham sections respectively for the forthcoming year, and Mr. H. A. McCarthy and Lt.-Col. A. J. Round, vice-chairmen.

MR. WILLIAM TAYLOR, who for the last 20 years has been clerk to the Examiners of Engineers, London, the Board of Trade and Ministry of War Transport, died recently.

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IN YOUR CUPOLAS
BY USING
STANTON
HOLWELL
or RIXONS
SAND-LESS
MACHINE CAST
PIG IRON
THE STANTON IRONWORKS COMPANY
LIMITED
NEAR NOTTINGHAM

NEWS IN BRIEF

A SCHEME for an industrial trading estate for new industries in the Medway area has been approved.

DRILLING FOR OIL has been started by Anglo-American Oil Company engineers at Gringley-on-the-Hill, near Doncaster.

LEA FOUNDRY (MATLOCK), LIMITED, is to be wound up voluntarily. Mr. R. N. Gooch, 4B, Frederick's Place, London, E.C.2, is the liquidator.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, Springburn, Glasgow, have received an order for 150 locomotives for the South African railways.

THE MINISTER OF NATIONAL INSURANCE has under consideration a proposal by ironfoundry workers in the Falkirk area that silicosis should be classified as an industrial disease in the light-castings industry.

SHANKS & COMPANY, LIMITED, sanitary engineers and ironfounders, of Barrhead, near Glasgow, turned out munitions to the value of £2,000,000 during the war years. The company are now proceeding with the mechanisation of their bath foundry.

VULCAN FOUNDRY, LIMITED, of Newton-le-Willows, Lancs, have completed a number of new design "Liberation" class locomotives ordered by the Ministry of Supply for UNRRA. They are being sent to Poland, Yugoslavia, and Czechoslovakia.

JOHN SHAW & SONS, WOLVERHAMPTON, LIMITED, hardware and tool merchants, manufacturers and exporters, have, in pursuance of their policy of further developing the manufacturing side of their business, disposed of their shareholding in their subsidiary company in India, T. E. Thomson & Company, Limited.

MR. ANEURIN BEVAN, Minister of Health, has asked the larger towns in England and Wales to place contracts at once for the B.I.S.F. type of permanent prefabricated house, designed by the British Iron and Steel Federation. Plans for immediate production on a large scale have been made by the Government. Delivery is expected to begin in May or June.

FALKIRK, centre of the light-castings industry in Scotland, is to have a new foundry which will be situated at Bainsford. The foundry will specialise in castings for electric cookers, irons and fires, and aluminium castings for the motor-car industry. To be known as the Merchiston Foundry, Limited, the new venture is to have a building of the most modern steel construction.

THE MINISTER OF SUPPLY and of Aircraft Production (Various Controls—Transfer to Supply) Order, 1946, effects the transfer, as from April 1, from the Minister of Aircraft Production to the Minister of Supply of Controls under the Control of Aluminium (No. 5) Order, 1940; the Control of Aluminium (No. 6) Order, 1945; the Light Metals and Alloys Fabrication (No. 1) Order, 1941; and the Control of Magnesium (No. 4) Order, 1942.

A RESOLUTION calling for a wage increase of £1 a week for foundry workers, plus a 40-hr. week, was passed in Glasgow on Sunday at a meeting of shop stewards and branch officials of the West of Scotland area of the National Union of Foundry Workers. The resolution, which is to be forwarded to the National Council of the union, also asked for an annual holiday of 12 days with pay and all statutory holidays, as well as a guaranteed working week.

AT A PRESS conference at Manchester, Mr. Aneurin Bevan, Minister of Health, announced that, to obviate the bottleneck in the foundry industry and help forward the housing programme, household baths and cookers of pressed steel were to be produced. In some instances, aluminium gutterings were also being produced, so that they might concentrate the productive capacity of the foundry industry on products for which they could not obtain substitutes.

WM. DOXFORD & SONS, LIMITED, shipbuilders, of Sunderland, have taken over the marine engineering works and quay of John Dickinson & Sons, Limited, marine engineers, etc., of Sunderland. The fitting-out quay will be used as an extension of the present quay facilities at their Pallion shipyard. The purchase has been made from the Richardson Westgarth marine engineering group, in which the North Eastern Marine Engineering Company (1938), Limited, is a principal concern. The latter company took over Dickinson's works in 1940.

OBITUARY

MR. BERNARD LEWIS, who for 36 years was manager of the ironworks of the Lilleshall Company, Limited, Priors Lee Hall, Shifnal, Salop, has died at the age of 72.

MR. DAVID MACKIE CURRIE, who joined the staff of W. H. Arnott, Young & Company, Limited, iron and steel scrap and non-ferrous metal merchants, of Glasgow, in 1933, has died, aged 54.

MR. HARRY BARNABY MAWDESLEY, who for many years was on the administrative staff of the Stafford Coal & Iron Company, Limited, Stoke-on-Trent, has died suddenly at the age of 77.

MR. RENE GUILLERY, Ingénieur A. and M., officer of the Legion of Honour, and managing director of Malicet & Blin, of Aubervilliers, has died in Paris. Mr. Guillery was particularly well known in scientific and industrial circles for his numerous inventions of testing machines.

MR. JAMES BOOTH, joint managing director of John Booth & Sons (Bolton), Limited, structural engineers, etc., has died at the age of 75. He was the eldest son of the late Mr. John Booth, founder of the firm. For many years he was on the executive committee of the Bolton and District Engineering Employers' Association.

MR. HARRY F. WINTERTON died early on Tuesday morning. He was chairman and managing director of Wm. Cumming & Company, Limited, manufacturers of foundry requisites, etc., of Maryhill, Glasgow, N.W., and elsewhere. Mr. Winterton was a past-president of the Institute of British Foundrymen.

Design by Eric Fraser

MOSAICS OF STEEL

NUMBER TWO

The Appleby plant is the most remarkable and modern in the country and is designed solely for the production of steel plates. Every process is carried out in an integrated manner commencing with the locally mined ore and continuing through to the rolling of finished plates destined for boiler making, shipbuilding, bridges and many other constructional purposes. As an island nation we have led the world in the design and construction of naval vessels of every type as well as many varied vessels for the mercantile marine, from the fast and beautiful ocean liner to the sturdy tramp steamer. For all these designs the plates rolled at Appleby find their applications.

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NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Plaspex Engineering Company, 34-35, Norfolk Street, London, W.C.2—£3,000.

John E. Moore, Lakeside Works, Yeadon, near Leeds—Metallurgists, etc. £10,000.

Brailey's (Engineers), 12, Pilton Street, Barnstaple, Devon—£5,000. W. Harris and P. C. Brailey.

Bonnington Castings, Bonnington Road Foundry, Leith—£60,000. G. M. and D. W. L. Menzies.

John Bromilow, William Street, Heywood, Lancs—Brassfounders. £5,000. J. H. and J. E. Cropper.

W. S. Engineering Company, 339a, Upper Richmond Road, East Sheen, London, S.W.14—£4,000. R. S. and M. E. Nash.

R. N. Saxby, School Works, Bridge Road, Liverpool, 18—Engineers, ironfounders, etc. £2,000. R. N. Saxby and J. E. H. Colvin.

Taycross, 10, Kensington Park Mews, London, W.11—Engineers, founders, tool and pattern makers, etc. £5,000. M. M. Taylor and R. E. Cross.

Joseph Wharton & Son (Maryport), Phœnix Foundry, Maryport, Cumberland—Engineers and ironfounders. £20,000. J. and J. C. C. Wharton.

M.C.C. Heating, 66, High Street, Wimbledon, London, S.W.19—£1,000. Heating and general engineers, etc. W. B. Mudie, A. J. R. Castle, and C. H. S. Clutterbuck.

B.I.S.C. (Ore), Steel House, Tothill Street, Westminster, London, S.W.1—£1,000. E. J. Pode, D. H. Kyle, H. Boot, A. J. Peech, N. H. Rollason, and L. F. Wright.

Mechanical Improvements Manufacturing Company, 53, Curnock Street, Camden Town, London, N.W.1—Engineers, designers and manufacturers of engines and engineers' tools. £5,000. E. E. Rouse.

S. Porter & Company, Duke's Road, Western Avenue, London, W.3—Manufacturers of lead and lead-lined plant, etc. £5,000. N. Swindin, H. L. Malan, A. E. Norman, and H. Evans.

Concentric Manufacturing Company—Manufacturers of precision brass fittings. £100,000. E. S. Cockrell, S. H. Sershall, S. G. Morgan, and T. Avery, 12, Pilkington Avenue, Sutton Coldfield.

Anochrome, Prince Street, Pleck, Walsall—Platers by electrical deposition or otherwise of nickel, chromium, cadmium and other metals, etc. £5,000. W. and E. V. Kelley, E. and D. A. Roberts.

Cliftons (Ashford), Tudor House, Tudor Road, Kennington, Ashford, Kent—Mechanical and general engineers, etc. £3,500. C. F. B. and G. F. Hayward, K. R. Geering, F. A. Knight, and E. G. Castney.

British Welding Research Association (limited by guarantee without share capital)—Council:—J. W. Baillie, 94-8, Petty France, London, S.W.1, H. Berry, Sir Leslie Boyce, I. R. Cox, Sir Claude D. Gibb, V. E. Greenwood, Lt.-Col. Sir J. Greenly, Sir W. J. Larke, Cmdr. Sir R. Micklem, Dr. J. H. Paterson, F. E. Smith, A. J. G. Smout, C. M. Spielman, and W. W. Watt.

CONSUMPTION OF NON-FERROUS METALS IN 1945

Details of the consumption in the United Kingdom during the fourth quarter of 1945 of the metals within the scope of the Directorate of Non-Ferrous Metals have now been issued, completing the figures for the year. These metals are copper, zinc, lead, tin, nickel, cadmium, antimony, cobalt and manganese.

Total figures of the consumption of virgin metal (only) by quarters in 1945 are as follow:—

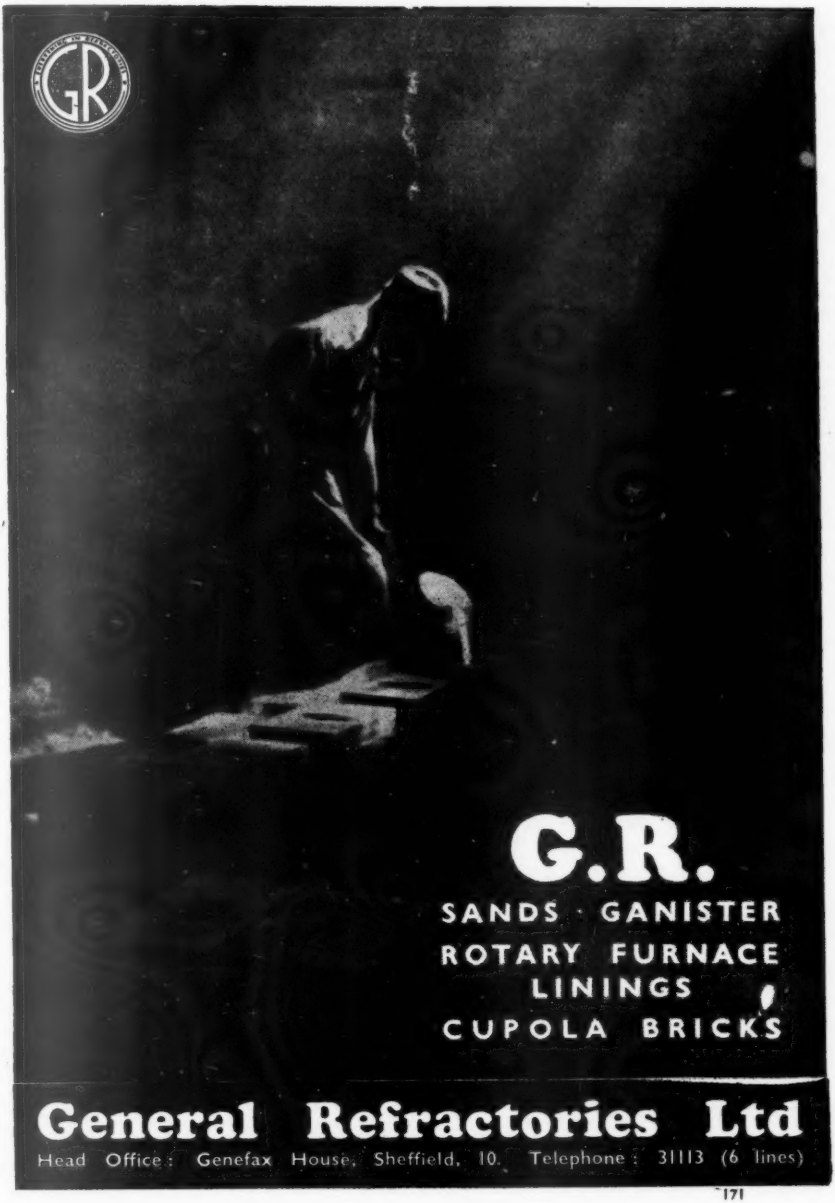
	First quarter	Second quarter	Third quarter	Fourth quarter	Total, 1945
Copper	81,103	72,378	65,244	69,888	288,613
Zinc	45,411	43,109	40,290	44,513	173,323
Lead	51,517	55,265	55,274	61,555	223,591
Tin	3,949	4,067	3,959	4,421	16,396
Nickel	2,388	2,214	1,966	1,820	8,388
Cadmium	114	121	101	103	439
Antimony	1,265	1,348	1,284	1,361	5,258
Cobalt	195	168	158	127	648
Manganese metal ..	144	134	107	105	490

In most of the more important metals, consumption in the fourth quarter of 1945 showed an increase of about one-tenth above the third quarter. In part, this is a reflection of the housing demands. An increase in the output of copper sheets and tubes, rolled zinc and zinc for galvanising more than counterbalanced a decrease in the demand for copper and zinc in brass products. The bulk of the lead increase was in sheets and pipes.

IN PARLIAMENT

Demobilised Foundry Workers

In reply to MR. NUTTING, who asked the Minister of Labour what steps were being taken to encourage demobilised Servicemen, formerly foundry workers, to return to employment in foundries; and what percentage of such Servicemen had in fact returned to this employment, MR. ISAACS said that in December, 1945, special publicity by means of Press and wireless was undertaken to make known the need of the ironfounding industry for additional workers, and ironfounding was included in a special advertising campaign which had as one of its objects the return of former workers to essential industries. Demobilised foundry workers who reported at employment exchanges were encouraged to go to foundry vacancies which had a high preference in view of their importance. Moreover, the release from the Forces under Class B of some 5,000 former foundry workers had been agreed. He regretted that the information asked for in the latter part of the question was not available, but it was known that large numbers of such Servicemen were returning to foundry work.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171

Raw Material Markets

IRON AND STEEL

Everything possible is being done to step up the production of pig-iron and it is satisfactory to note that the efforts put forward by the blast-furnace owners and the Control are meeting with some success. Arrangements are being made for another furnace in Northamptonshire to go into production on foundry pig-iron early next month. Large quantities of high-phosphorus pig-iron will be needed to meet the demands of the light-castings trade. Every light foundry in the country is overwhelmed with orders. Housing schemes call for numerous castings for external and internal fitments.

Activity among the general engineering, speciality and jobbing foundries also is increasing. There is a growing demand for castings for the engineering industry, which is slowly getting back into its stride. There appears to be sufficient pig-iron of special grades to meet the needs of the foundries. For some time makers of refined iron have been unable to find outlets at home for all their production and they have been pressing the Control to grant permission to export. This has hitherto been steadily refused, but in the last week permission has been given for limited quantities of refined iron to be exported to non-sterling areas.

The foundry coke position is not unsatisfactory in the circumstances, but it cannot be said that supplies are plentiful. Consumers are fortunate if they can secure sufficient to meet their current requirements without having to dip into stocks.

Supplies of limestone and ganister are coming through without much delay and cupola firebricks can be secured at reasonably short notice.

There is strong pressure on the steelworks for supplies of semis for the re-rollers. The sheet trade is very busy and is likely to remain so for the rest of this year. Output for the next six months is already taken up and it is essential that the mills should be supplied with large quantities of sheet bars if they are to maintain full production. Re-rollers of bars, strip and light sections need square and flat billets in substantial tonnages and many of them are being incommoded because of the dearth of supplies, particularly of the smaller sizes. Home supplies are not sufficient for the re-rollers' requirements and some reliance has to be placed on imported supplies arranged by the Control. Semi-finished steel is coming in from Canada and Australia, but larger quantities would be welcomed to assist in meeting the strong demands for all forms of finished steel in this country.

Some of the plate rollers are now off the market and have advised customers that they cannot take on any additional commitments for months to come.

NON-FERROUS METALS

There has been no announcement yet—at least at the time of writing—as to the arrangements for supplies of lead in the second quarter of the year. It is assumed that quantities will continue to be rationed, but no further increase in price is expected. Supplies of the other non-ferrous metals are reasonably free, but the position in some respects is not without anxiety. Labour troubles in the copper belt of the United States have resulted in a sharp contraction of copper production on the other side of the Atlantic and the position there may ultimately be reflected here. Zinc is obtainable in reasonable tonnages, and there is no difficulty in securing supplies of aluminium and other light metals.

The Combined Tin Committee has now made further interim allocations of tin to be operative immediately against requirements for the first half of 1946. The total quantity of tin in long tons made available by the Tin Committee to the various countries now stands as follows: Canada 1,500, Denmark 200, France 4,260, India 960, Middle East 350, Netherlands 360, Norway 220, South America 200, Sweden 200, Switzerland 400, UNRRA 3,000, and the United States 6,650. A further interim allocation to South America will be made at a later date. In general, the tonnages concerned will be made available from United Kingdom or Belgian sources of supply and, in the case of South America, from the United States; also, however, in the case of Switzerland 80 tons may be obtained from the Netherlands under the terms of a trade agreement between the two countries. In the case of the United States 2,000 tons may be obtained from Siam and 150 tons from the Netherlands East Indies. Although the Committee takes account of the semis position in making allocations of tin, the Committee does not allocate semi-manufactures which may be obtained from any available source.

CONTRACTS OPEN

Any date given is the latest on which tenders will be accepted. The address is that from which forms of tender may be obtained.

Aylesbury, April 8—Supplying and laying of approximately 200 yds. of 3-in. spun-iron main and specials, for the Bucks Water Board. Mr. G. Smethurst, water engineer, 22, Walton Street, Aylesbury. (Fee £2 2s., returnable.)

Horsham, April 8—Water mains, for the Urban District Council. Mr. A. Slyfield, clerk, Council Offices, Horsham Park, Horsham, Sussex.

Huddersfield, April 5—Cast-iron materials for the 12 months ending March 31, 1947, for the Corporation. The Borough Engineer and Surveyor, High Street Buildings, Huddersfield.

THE FOLLOWING FIRMS have been elected as ordinary members of the British Cast Iron Research Association, the names of the representatives being given between brackets:—Foundry Services, Limited, Birmingham (J. L. Francis); John Gardom & Company, Ripley (J. W. Gardom); John Heine & Son Pty., Limited, Leichhardt, N.S.W. (A. Heine); Joseph Lucas, Limited, Birmingham (Dr. J. D. Jevons); Richardson Foundries, Footscray, Victoria, Australia (Harold C. Richardson).